South Dakota.—With the exception of three or four days, the first and second decades of the month were comparatively mild, but the third decade was marked by continued and steady cold weather, although the extremes of cold were not as great as usual. The average depth of the snow on the ground on the 15th was 1.6 inch, and on the last day of the month, 3.00.

Tennessee.—This has been a rather cold, wet month. The temperature averaged about 2° below the normal during the entire month, while there were but six days on which there was no precipitation. The most severe cold of the month reached us on the night of the 11th, reducing the temperature to from 1° above zero in the western portion of the State to 15° below zero in the northeastern portion. With one exception, 1892, the month averaged colder than any January since 1886.

The cold weather has caused much suffering among stock, but on the whole has been beneficial to the farmer, keeping back vegetation, etc. Wheat has been protected by a covering of snow and is said to be in excellent condition. The sap has been kept down in fruit trees, and if these conditions continue until the opening of spring we may expect a good crop and fruit yield throughout the State.

Texas.—The temperature on an average for the State was 1.5° above the normal. Several light northers crossed the State during the month, and two severe ones were experienced. The coldest weather over the southern portion of the State prevailed about the 10th of the month, when the temperature fell to about freezing or slightly below, while the lowest temperatures over the northern and central portions were reported between the 28th and 31st, inclusive.

The precipitation on an average for the State was 1.16 inch below the normal. The rainfall was not well distributed during the month, and was hardly sufficient for farming interests, except over the northeastern portions of the State, where a heavy rainfall was experienced.

Utah.—The first half of the month was comparatively mild and pleasant, with temperatures generally above the normal. During the last half the weather was more or less stormy at intervals, with a severe cold wave on the 28th, which caused the lowest temperatures recorded during the month.

Virginia.—The temperatures averaged slightly below the normal in the tidewater sections, while the deficiency increased to the westward. The total amount of precipitation averaged about or very slightly above the normal near the coast and from 50 to 75 per cent above the normal in the other sections, with more than the average amount of snowfall. The snowfall proved generally beneficial to winter wheat, oats, etc.; especially in the northern and western sections of the State.

Washington.—It appears to be the impression of a great many that the weather thus far this winter has been unusually mild in Washington. Such is not the case, and the current month had a mean temperature which was 1½° below the normal. There have been no extremely low temperatures, and, on the other hand, the maximum temperatures were not as high as in former years. In eastern Washington the lowest temperature at the coldest station was only 6° below zero. No violent storms passed over the State, although there were two rather severe ones, which swept the coast. The rainfall was well distributed throughout the month.

West Virginia.—The average temperature for the month was below normal. On the 12th the drop in temperature was phenomenal, the fall varying from 40° to 50° in less than twenty-four hours, and was accompanied by considerable snow. Snowfall was fairly distributed throughout the month.

Wisconsin.—The mean temperature for the month was 3.6° below the normal; precipitation 0.17 of an inch below the average for the month. A very severe storm entered the State from the southwest on the night of the 20th, and continued, with increasing force, during the 21st, passing off to the northeast on the evening of that day. Rain and sleet, accompanied by thunder and lightning, prevailed throughout the central and southern portions on the night of the 20th and early morning of the 21st. This was followed in the afternoon by a westerly gale, with a wind velocity of 50 miles per hour at Milwaukee, heavy snow, and zero temperatures. Another severe snowstorm occurred on the 25th, accompanied by high northeast gales, which drifted the falling snow and caused great inconvenience to railroads. This was followed by extreme cold weather, which continued to the close of the month. The cold was so severe that the ground froze to a great depth, and many complained of vegetables being frozen in the cellars.

Wyoming.—The mean temperature for the month was 20°, which was slightly lower than the average for January. The average amount of precipitation for the State was 0.95 of an inch, which was about one-third greater than the usual January precipitation.

STUDIES BY FORECAST OFFICIALS.

As a preliminary study to active forecast duty the officials of this division are given subjects for investigation from time to time. The following paper, prepared under the direction of Maj. H. H. C. Dunwoody, U. S. A., assigned as Acting Assistant Chief of Bureau, in charge of Forecast Division, is published with his consent.

TYPES OF STORMS IN JANUARY.

By E. B. GARRIOTT, Forecast Official.

Classified with reference to the regions in which they first appeared, the January storms traced in the MONTHLY WEATHER REVIEW during the last ten years fall under the following general heads:

Region in which storms first appeared.	Total number of storms in ten years.
Saskatchewan Valley	32
Southwestern States	21
North Pacific coast	20
Northeast Rocky Mountain slope	8
Middle-Western States	7
Ohio Valley and Tennessee	3
Southeastern States	2
South Pacific coast	0
Total number in ten years	94

About 80 per cent of these storms belonged to what may be termed three principal types. One type, which presented the greatest number, embraced storms that advanced from the Saskatchewan Valley; another included storms that first appeared in the Southwestern States, and the third storms which moved eastward from the North Pacific coast. The remaining storms, which were generally secondary developments to low areas of the three principal types named, were widely distributed, and while their relatively limited number will not justify their acceptance as independent types, the fact that they collectively composed one-fifth of the storms of the month, calls for a consideration of their characteristics as secondary types.

STORMS FROM THE SASKATCHEWAN VALLEY.

Chart 1 shows the tracks of all January storms that entered the region of observation north of Montana and North Dakota during the last ten years. Twenty-one, or fully two-thirds of these storms reached the Atlantic coast, and all but three of this number passed to sea north of the fortieth parallel. The plotted paths show that the usual path of storms of this general type is east-southeast over the Canadian Maritime Provinces, and it may be assumed that similar and well-marked weather and temperature changes and conditions will attend storms of seasonal severity and average speed that follow the average track. It may also be assumed that unusual and particularly notable changes and conditions will be presented in connection with storms that depart from the usual path. The principal problem in practical forecasting is to calculate the direction of movement, speed, and intensity of a storm at the time of its first appearance in a defined district. In the case of Saskatchewan Valley storms we know that two out of three of these storms pass east-southeast to the Atlantic coast north of the fortieth parallel, and that their average velocity is about 37 miles per hour. In discussing these storms, an effort will be made to connect their movements with the general distribution of pressure and temperature, and to point out those conditions which favor normal movements and the causes which seemed to occasion abnormal movements.

A storm remarkable both as regards its direction of movement and speed swept rapidly southeastward from Alberta to

Arkansas, and thence off the Atlantic coast January 13–15, 1893. This storm appeared over Alberta the morning of January 13, and the general conditions which obtained at that time are shown on Chart 9. It is evident that the distribution of pressure and temperature positively prohibits an early eastward movement of the storm. The barometric gradient in that direction is steep, and the temperature is some 50° lower over Manitoba than near the storm's center. In a previous paper the statement was made that isotherms are the leading strings of a storm, and attention was called to the recognized inclination of storms to advance in the direction of least barometric resistance. In the case of this storm both of these conditions favor a movement of the storm down the eastern Rocky Mountain slope, and, as the isobars loop far to the southward, an unusually rapid movement may be anticipated. Chart 10 of the morning of the 14th, shows the 12 and 24 hour movement of the center. It will be observed that the rapidity of the storm's movement, which was at the rate of about 54 miles per hour, did not permit a warming up of the air in the east quadrants of the low area, and upon its arrival in the southwest the isotherms still ran southeastward across its line of advance, with freezing temperature as far south as northern Florida.

Although a sudden and marked rise in temperature might be expected to precede, and very low temperature to follow, the passage of the storm over the east-central districts, the colder air which appeared in its front the morning of the 14th, rather favored a loss of strength. The report of the following morning, Chart 11, shows that the low area flattened or divided against the cold area, and that the separate low areas reunited off the middle Atlantic coast. This storm is an excellent example of the influence of low temperature upon a storm's movement. It was opposed by much lower temperature in its front until it reached the southwest, and in endeavoring to skirt the cold area, nearly perished for lack of warmth, which is one of the sustaining elements of a storm. It followed the path of least barometric resistance, and, encountering but slight opposition in that respect, traveled at a high rate of speed. Owing to its great velocity, low temperature, which is unfavorable to precipitation, preceded and attended its passage, and no precipitation occurred save in the eastern districts where sharp temperature changes and gradients in a moist atmosphere produced a heavy fall of snow throughout the Atlantic coast States north of Florida.

A typical storm of the Saskatchewan Valley type appeared over Alberta, January 20, 1892, and reached the Canadian Maritime Provinces January 23, traveling over the most frequented track of storms of this class at an average velocity of about 39 miles per hour. The daily progress of this storm and the conditions which attended its passage are shown on Charts 12 to 15. The morning reports of the 20th, Chart 12, present conditions which prevailed just before the full development of this storm within the region of observation. At that time a storm occupied the Lake Superior region, and the trend of the isobars and isotherms favored a rapid eastward movement of the Alberta storm. By the morning of the 21st, Chart 13, the Lake Superior storm had moved eastward to a position north of Lake Huron, and the northwest low area had moved eastward over the Saskatchewan Valley a corresponding distance. Between the low areas the pressure had risen. The appearance of a crest of high pressure between low areas moving over the northern districts, can, as a rule, be expected, and the lower temperature and higher pressure can, as in this case, be relied upon to rapidly give way and follow in the wake of the eastern low, allowing the western low area to advance at a normal velocity. In the present instant the high area disappeared during the 21st, and the northwest storm moved eastward over Manitoba, and by the morning of the 22d, Chart 14, had reached Lake Superior. Its after course to the Maritime Provinces was unobstructed, and its passage was unattended with noteworthy features.

Storms of this type, which follow the most frequented path over the northern Lake region, are seldom attended by precipitation until they reach the Lake region, and during their passage thence eastward the rain area is usually confined to the Great Lakes, New York, and New England. Neither are they, as a rule, attended by cold waves, save in the case of the slower moving storms of marked intensity which produce high temperatures in the east quadrants and are followed by a strong sweep of northerly winds. The storms which pursue a more southern course are, however, often attended by areas of precipitation which extend to the Gulf States and by cold waves which reach the southern limit of the barometric trough.

NORTH PACIFIC COAST STORMS.

These storms present characteristics similar to those noted in connection with the Saskatchewan Valley type. A majority of the storms of both types doubtless spring from the extreme eastern limit of the permanent winter low area of the north Pacific Ocean. The north Pacific type of storms as herein classified, however, strike the American coast farther south, and a reference to Chart 3 will show that their tracks are more widely distributed and, on the whole, run farther south than those of the Saskatchewan Valley type. Of the 20 storms of this class traced for the last ten years, 10 reached the Atlantic coast, all, save one, passing to sea north of the fortieth parallel. In this connection it is interesting to note that this result compares closely with figures found in Bulletin A of the Weather Bureau. During the ten years covered by that report an average of 1.8 storm per month appeared on the north Pacific coast and traversed the North American continent in January. The tables found in the Bulletin show that the storms that appear on the north Pacific coast of the United States in winter possess greater vitality than any other class of storms traced over the Northern Hemisphere, and that in a ten-year period 18 storms from that region traversed successively the North American continent and the north Atlantic Ocean during the three winter months.

These storms usually cross the continent in about three days, at an average velocity of 35 to 40 miles per hour. After passing east of the Rocky Mountains they assume the characteristics noted in connection with storms of the Saskatchewan Valley type. The storms that pass well to the southward of the forty-fifth parallel carry precipitation to the Gulf States, and the cold-wave areas, depending upon the storm's intensity and previously existing temperatures, usually cover districts included within the low barometer troughs which are swept by the northerly winds of the storm's west quadrants.

NORTHEAST ROCKY MOUNTAIN SLOPE STORMS.

The northeast Rocky Mountain slope type of storms, Chart 4, also belongs to this general class, but, owing either to unusually rapid movements, which carry them across the mountains between reports, or to slight intensity, they do not appear as fully developed storms until they reach the eastern slope.

SOUTHWEST STORMS.

Probably the most important winter storms of the eastern half of the United States are those which first appear in the southwestern States. About one-half of the storms that reach the Atlantic coast belong to this and kindred southern types, and the rain and temperature change areas are more extended, general, and pronounced than in any other class of storms that traverse districts lying east of the one-hundredth meridian. Storms of this type almost invariably move northeastward, and, unless the conditions are complicated by northwest low areas, they reach the Atlantic coast within forty-eight hours. Storms of average intensity which appear over the interior of the west Gulf States or on the extreme southern Rocky Mountain slope usually cross the Ohio Valley and the Lake region, attended by general rain or snow over the eastern half of the country, and those which advance from the immediate Gulf coast or from over the west part of the Gulf of Mexico move almost due northeast, producing areas of general rain over the Southern and Atlantic States, the upper and middle Ohio Valley, and the eastern Lake region, and are often attended by cold waves and dangerous gales in those districts. During the last ten years 21 storms have appeared in the southwest in January, and in all but one instance they reached the Atlantic. About one-half of this number crossed the Lake region and passed thence over or north of the St. Lawrence Valley; the others traversed the Atlantic coast States. The general features and characteristics of these storms can best be shown by discussing subtypes of the general type referred to.

A storm of the class that first appears on the extreme southern Rocky Mountain slope advanced from Texas to southern Lake Michigan from the morning of January 8 to the morning of January 9, 1889, crossed Lake Huron and reached a position far to the northeast of Georgian Bay by the morning of the 10th, and passed eastward over Labrador during the 11th. This storm was faintly outlined over the southern Rocky Mountain region on the 7th, and by the morning of the 8th had reached the position shown on Chart 16. By the evening of the 7th rain had set in over the southwest, and by the time the storm had become well marked over Texas the rain area had extended over the Mississippi and lower Ohio valleys. A study of Chart 16 shows that the pressure and temperature distribution favors an almost due northeast movement of the center of disturbance. The path of least barometric pressure resistance lies in that direction, and the northward loop of the isotherms over the Mississippi and lower Ohio valleys shows the region of increasing temperature toward which the storm is likely to move with the favorable pressure conditions presented. As is usual in storms of this class, the rain area which covers the Mississippi Valley can be expected to reach the Atlantic coast within twenty-four hours. It has been observed, however, that when a storm is central in Texas about thirty hours are required for the rain area to overspread New England. The high area over the northern plateau region will move rapidly southeastward and replace the low area in the southwest, causing a decided fall in temperature within the cyclonic area which appears on this chart; in fact, a cold wave can safely be anticipated within the storm area, say within the area covered or surrounded by the isobar of 29.70. Chart 17 shows the movement of the storm during the succeeding twenty-four hours. A notable feature is the rapid deepening of the barometric depression. The other conditions are as outlined in remarks relating to Chart 16. The high area has moved rapidly southeastward, the temperature is some 20° lower in the southwest, and the rain area has extended to the Atlantic coast south of New England, and will extend over that district during the next few hours. As the storm center will now move well to the northward of the St. Lawrence Valley, and the sweep of the northerly winds will not be strong, save over extreme northern districts, temperature falls sufficient to constitute a cold wave can not be expected within the next twenty-four hours, and rapidly-rising barometer in the south and southwest point to a rapid clearing of the weather in the central and southern districts. The report of the following morning, Chart 18, shows the storm well beyond our region of observation, and its further influence will be in the form of diminishing westerly gales along the middle Atlantic and New England coasts and over the eastern Lake region.

The second class of this type of storms first appears near the immediate west Gulf coast, and move northeastward, parallel with, and generally somewhat to the westward of the Appalachian range, and cross eastern New York and New England, the average time of transit being about forty-eight hours. A good example of a storm of this class appeared on the Louisiana coast the morning of January 26, 1889, and the conditions which obtained at that time are exhibited by Chart 19. As rain had been falling over the southern and southeastern districts during the preceding two days, the actual rain area controlled or occasioned by this storm can not well be determined. A study of these storms has shown, however, that when fair weather prevails over the central and eastern districts at the time of the first appearance of the low area on the Gulf coast, the rain area spreads rapidly from the Gulf and covers districts east of the Mississippi and south of the Great Lakes within twenty-four hours and extends over New England within thirty-six hours.

When this storm appeared on the Louisiana coast the morning of the 26th, a trough of low pressure extended thence over the eastern Lake region and the St. Lawrence Valley, and the isotherms looped northward over the Ohio Valley and the lower Lakes. These conditions plainly indicate the direction of the storm's advance, and, as neither pressure gradients nor low temperature oppose the advance of the center, it may be assumed that the movement will be rapid. The rain area, which covers districts south of the Ohio River, may be expected to cover New England within twenty-four hours, and the barometer will rise rapidly with a decided fall in temperature in the southwestern States, the fall constituting a cold wave in the west Gulf States. Chart 20 shows the progress made by the center of disturbance during the succeeding twenty-four hours. The storm has increased in intensity and rain has fallen throughout the central valleys and in the Atlantic coast States. The conditions presented the morning of the 27th seem, at first glance, unfavorable to a normal northeast advance of the storm center. It will be observed that a well-marked area of high pressure has appeared over the Canadian Maritime Provinces, with a decided fall in temperature in that region. Under certain conditions high areas of this class retard, and even force back storms advancing from the interior. When this occurs the northeast high area is usually one of gradual growth and apparently well anchored, and the barometer is relatively low in the north-central districts with a gentle barometric gradient and high temperature for the season in that direction. When, as in the present instance, the western and northwestern districts are covered by an unbroken high area of great magnitude, with much lower temperature to the west and northwest of the low area, the center of disturbance can scarcely recurve in that direction, and may be expected to increase in intensity, warm up the cold area in the northeast by a strong indraught of ocean air, and force a passage along the usual path. So far as January storms are concerned the tracks plotted on Chart 2 show that during the last 10 years the southwest type of storms have, without an exception, continued a northeast course after leaving the Gulf States. The morning report of the 28th, Chart 21, shows that this storm increased greatly in strength and advanced in a direct line toward the Canadian Maritime Provinces, either forcing eastward or dissipating the high area which occupied that region the preceding morning. In the meantime the center of the high area in the west remained nearly stationary and the pressure in the Northwest and over the western Lake region decreased instead of increased, as might have been expected, and increased but slightly in the southwest. The effect of these minus pressure changes in the west and northwest was to delay the clearing of the weather which generally closely follows the passage of these storms, and the cloud and rain area lingered over the Ohio and middle Mississippi valleys, and a decided fall in temperature occurred only in the cleared region which covered the interior of the southwestern States.

A representative storm of the third class of low areas of this type (that is, those storms which appear fartherest south and cross the west part of the Gulf of Mexico and pass thence northeastward over the east Gulf, south and middle Atlantic States) first appeared near the mouth of the Rio Grande River the morning of January 23, 1891, advanced to central Alabama by the morning of the 24th, moved thence northeastward off the middle Atlantic coast during the early morning of the 25th, and disappeared in the direction of Nova Scotia during the latter-named date, traversing the territory lying between the mouth of the Rio Grande and a point off the southeast New England coast in forty-eight hours. Chart 22 shows the first indications of the presence of this storm off the mouth of the Rio Grande River. The exact location of the center can only be surmised, but a calculation based upon the well known persistency and uniformly rapid movement of this class of storms, and the absence of a pressure gradient to the northeastward, would give the storm a movement to the middle Gulf States within twenty-four hours, and as precipitation is one of the first well-marked features of these disturbances, rain could be expected over a large area of the Southern States. Within twenty-four hours the center of this storm had advanced to Alabama, and Chart 23, of the morning of the 24th, presents no material obstacle calculated to prevent the storm from continuing a northeast course. The area of high pressure on the middle Atlantic coast has shifted to that position from the south Atlantic coast and is moving; it will not, therefore, oppose the advance of the storm, more especially as the temperature is high and the direction of the isotherms is northeast from the storm center. As the barometer has risen rapidly in the rear of the storm, forming a high area in the southwest, a rapid rise of pressure and rapidly clearing weather will follow closely in the wake of the storm. Like storms that traverse the Atlantic coast States from the Gulf, this low area was unattended by marked changes in temperature in the Atlantic coast districts. The storms that appear over the east Gulf and the east Gulf States in January generally belong to the type herein considered, and do not, therefore, call for individual mention.

GENERAL REMARKS.

From the foregoing charts and remarks it would appear that the storms of January belong to three, and possibly to but two, general types which may be subdivided into a limited number of classes. We have seen that fully one-half of our January storms advance from the Saskatchewan Valley and the north Pacific coast, and that of these types the storms of the first-named type are the most numerous. Many, if not all, of the Saskatchewan type are of Pacific coast origin, and the two types can, therefore, be properly combined and termed the north Pacific type, the difference being merely that the storms traced on Chart 10 reach the coast farther south than those of the Saskatchewan Valley type. A large proportion of these storms doubtless originate near the American coast, and do not advance from the Bering Sea permanent winter low area. The plotted tracks of storm in Weather Bulletin A show that at least four-fifths of the storms that appeared on the Pacific coast north of the mouth of the Columbia River during a period of ten years first appeared near the coast, and did not actually travel eastward from the north Pacific or Bering Sea low area. The Bering Sea low area loops far to the eastward and reaches the Alaska coast in the neighborhood of Sitka in January, and this circumstance, taken in connection with the fact that the cold Arctic current flowing southward through Bering Sea Straits and the warm Pacific drift current meet south of the Alaska Peninsula, presents conditions which doubtless largely contribute to the development of storms off the Alaska coast south of the Alaska Peninsula.

The three branches representing the average paths of the north Pacific type of storms are shown on Chart 25. The north, or Saskatchewan branch, and the north Pacific branch, converge and meet in the St. Lawrence Valley, and the northeast Rocky Mountain branch swings slightly to the southward of the north Pacific branch over the northwestern States, and crosses and passes to the northward of the Saskatchewan Valley branch northeast of Georgian Bay. A result of the more southern path of the north Pacific and northeast Rocky Mountain slope storms is to carry precipitation and marked temperature change areas farther south, and these storms are more liable to be attended by secondary developments still farther to the southward, thereby causing general rain or snow over a great extent of country.

The second principal type, which embraces storms that first appear in the southwest, is also divided into three branches, all of which run almost due northeast. Storms of this class doubtless develop in the lee of the southern Rocky Mountains in the United States and to the eastward of the mountain ranges of Mexico, and an important element of their origin is found in the meeting over those regions of the warm, moist, easterly winds, which blow off the Gulf of Mexico, and which are really the western edge of the north Atlantic trade winds, and the cold, dry, northwest to north winds which sweep southeastward and southward along the eastern Rocky Mountain slope. As before stated, the storms of this principal type are the most important that traverse the eastern half of the United States in January. They are attended by widespread and abundant precipitation and decided temperature changes, and are the most methodical storms as regards their direction and velocity of movement that appear within the region of observation.

COLD WAVES.

A discussion of winter storms and weather would be incomplete without a reference to cold waves. The conditions producing and attending these phenomena are so complicated, however, that even a general discussion of the subject, calculated to prove instructive to forecasters, is attended by marked difficulties. The resolving into types of the innumerable combinations presented in connection with the development and appearance of cold waves, is an extremely difficult if not an impossible task, and the scope of this paper will admit of only a general discussion of their more prominent characteristics, and of a few remarks touching upon recognized conditions favorable to their entry into and progress over the United States. The visible mechanism of a cold wave embraces the cyclonic and anticyclonic areas which traverse the United States from west to east. The low areas warm up the surface air by the southerly winds in their east quadrants, and the cold, dry, northerly winds in their west quadrants that usher in the succeeding high area from the British Northwest Territory, occasion a marked fall in temperature which is termed a cold wave. It is evident, therefore, that generally speaking, the region covered by a cold wave must be successively subjected to the wind circulation of the east and west quadrants of a well-marked low area. It is also evident that the cold waves of the several sections are practically dependent upon the passage of low areas followed closely by unbroken high areas.

Thus far the mechanism seems simple and easily understood, and if the movement and strength of the high and low areas could be accurately foreseen, the forecasting of cold waves would be one of the simplest instead of one of the most difficult features of weather forecasting. As a matter of fact each of the many districts of the United States presents geographical and topographical features calculated to modify or intensify approaching cold waves. The probable intensity of a cold wave must be calculated for the varying conditions peculiar to each of the districts, and in many instances for conditions peculiar to localities. Unlike warm waves, which often produce in the central and northern districts temperatures higher than those noted in more southern latitudes to the windward, cold waves are not attended in the central and southern districts by temperatures lower than those noted to the north and west. On the contrary, the cold waves diminish in intensity as they sweep south and east, so far as the degree of actual cold is concerned, although the temperature may be relatively lower with reference to the normal temperature. As cold waves approach the moist regions of the Great Lakes and the Gulf and Atlantic coasts, conditions must be very marked to insure their overspreading those districts. For, as cold waves follow general storms, and as areas of precipitation, and even of cloudiness, are generally fatal to the advance of a cold wave, the forecaster should be very certain that the weather will clear up in a district before ordering cold-wave signals for that district.

Herein lies the difficulty of verifying cold-wave signals in the coast and Gulf regions; for the weather is often slow to clear up in the Gulf and Atlantic coast States, and in addition, there sometimes appears to be a slight fœhn effect produced in districts to the leeward of the Appalachian range of mountains; this, however, has not been proven. In the Southern States cold waves can rarely be successfully forecasted unless a well-defined low area crosses that region, followed by a well-marked and unbroken high area which has occasioned a decided cold wave in districts to the west or northwest. Twenty-four to thirty-six hours are usually required for a cold wave to advance from Texas to the south Atlantic coast. In January the cold waves of the central and northern districts attend the passage of the general type of storms that pass eastward from the north Pacific coast and the Saskatchewan Valley. As these cold waves drop down from the British Northwest Territory in the rear of and immediately follow the storms of this type, they assume corresponding velocities. The average time for a cold wave to advance from the British Northwest Territory to the middle Atlantic and New England States would, therefore, be sixty to seventy-two hours. But as the storms vary in velocity, so would the time required for a cold wave to sweep the northern regions vary. In all cases the velocity of cold waves must be governed by the velocity of the low areas and of the succeeding high areas, and their intensity upon the observed temperature distribution, and the intensity of the low and high areas which promote, sustain, and propel them.

NOTES BY THE EDITOR.

LOCAL CONTRAST OF WEATHER AT LONG BRANCH.

Mr. W. D. Martin, displayman U. S. Weather Bureau, Long Branch, N. J., reports that—

On January 29, in the morning, along the beach at that place the temperature was high and spring-like, but that two blocks back from the beach, namely, about 500 feet, it was cold and raw, and also snowing, with a light northeast wind, and that he had never experienced any phenomenon like this during sixteen years' residence on the coast. The reverse phenomenon is quite common, viz, in the summer time there occurs cold and raw weather along the beach with a west and northwest wind, while it is very hot at a little distance back. The latter phenomenon seems easily explained but the former not.

The inland temperatures at 8 a. m. and 8 p. m. were: Philadelphia, 18 and 24; New York, 18 and 24; Atlantic City, 22 and 24. Apparently the northeast wind had blown relatively warm surface water on to the New Jersey shore so that the local sea breeze was warm and moist, but as it penetrated inward and rose it mixed with the cold land air and the moisture was precipitated as snow.

THE ICE CROP FROM A METEOROLOGICAL POINT OF VIEW.

The observer at Clinton, Iowa, states in his January report that the cleanest and most transparent ice ever harvested was gathered during this month. Mr. J. Warren Smith, editor of the Bulletin of the New England Weather Service, states that observations show that the coldest places in New England are in the deep narrow valleys in the mountain regions, so we naturally expect the ice to form thicker on ponds in valleys during a cold spell.

Mr. W. R. Perry, of New London, Conn., inquires: "Have you any information that will enable me to choose the best location for an ice pond on the line of the New London Northern Railroad? Notwithstanding the general fact that the valleys are colder than higher ground in the same vicinity, my experience is that the higher up the pond is located the thicker the ice. Thus, at Belchertown, Mass., in 1890, the ice measured several inches thicker at the pond on the hill than at another pond in the valley a mile to the northward. At Winchester, N. H., the ice on Forest Lake was always thinner than in the pond on top of the mountain near by." He has noticed that a pond exposed to the wind at low temperatures froze rapidly after the wind went down, and usually overtook a less exposed pond that had several inches the start. He thinks that water kept in motion while cooling, so as to prevent freezing on the surface, produces anchor ice. "The best quality of ice comes from either of two reasons, sufficient depth of pond, say 30 feet, or a sufficiently rapid current to remove the air which gives it a white, transparent look." The inquiry thus started by the New England Weather Service has a very considerable practical value and theoretical interest. On the one hand observers near water ponds and streams, and the keepers of reservoirs, can contribute much to our knowledge of this subject by keeping a daily record of the temperature of the water at the surface, and also at several depths, in both the shallow and deep portions of the ponds. The records should be kept up throughout the year and studied with regard to the influence of winds and clear sky. On the other hand a theoretical study into the mode of action of whatever may influence the temperature is necessary in order to properly utilize such observations in explaining the past or predicting the future quality of the ice or in locating the best ice ponds.

A SILENT ELECTRICAL AND DUST STORM IN OKLAHOMA.

Dr. J. C. Neal, director of the Oklahoma Agricultural and Mechanical College, reports as follows:

During the morning of January 20 the sky was filled with cirrus clouds, very feathery and white. In the afternoon it became hazy, then dark, and looked like rain. Wind in puffs from the southwest. At nightfall the sky cleared, but somewhat hazy. At 8 p. m., seventy-fifth meridian time, the wind changed to the west, and a gale began; by 9 p. m. it was frightful. The dust passed along in columns fully 1,000 feet high, the wind arose to a speed of 35, then 45 miles per hour, with gusts reaching 55 miles, the temperature fell rapidly, and we saw for the first time (about 9 p. m.) flashes of light that apparently started from no particular place, but pervaded the dust everywhere. As long as the wind blew, till about 2 a. m., January 21, this free lightning was everywhere but there was no noise whatever. It was a silent electrical storm. This morning the sky is clear and except that the dirt is piled up over books, windows, and in all the house, no one would know what a fierce raging of wind and sky we had.

OBSERVATIONS AT HONOLULU, HAWAIIAN ISLANDS.

As the weather on our Pacific coast depends so largely upon the conditions of the atmosphere to the westward, it is considered important to publish in full and as soon as practicable the data furnished by observers in Alaska, the Hawaiian Islands, and adjacent regions.

Chart 1.

Saskatchewan Valley.

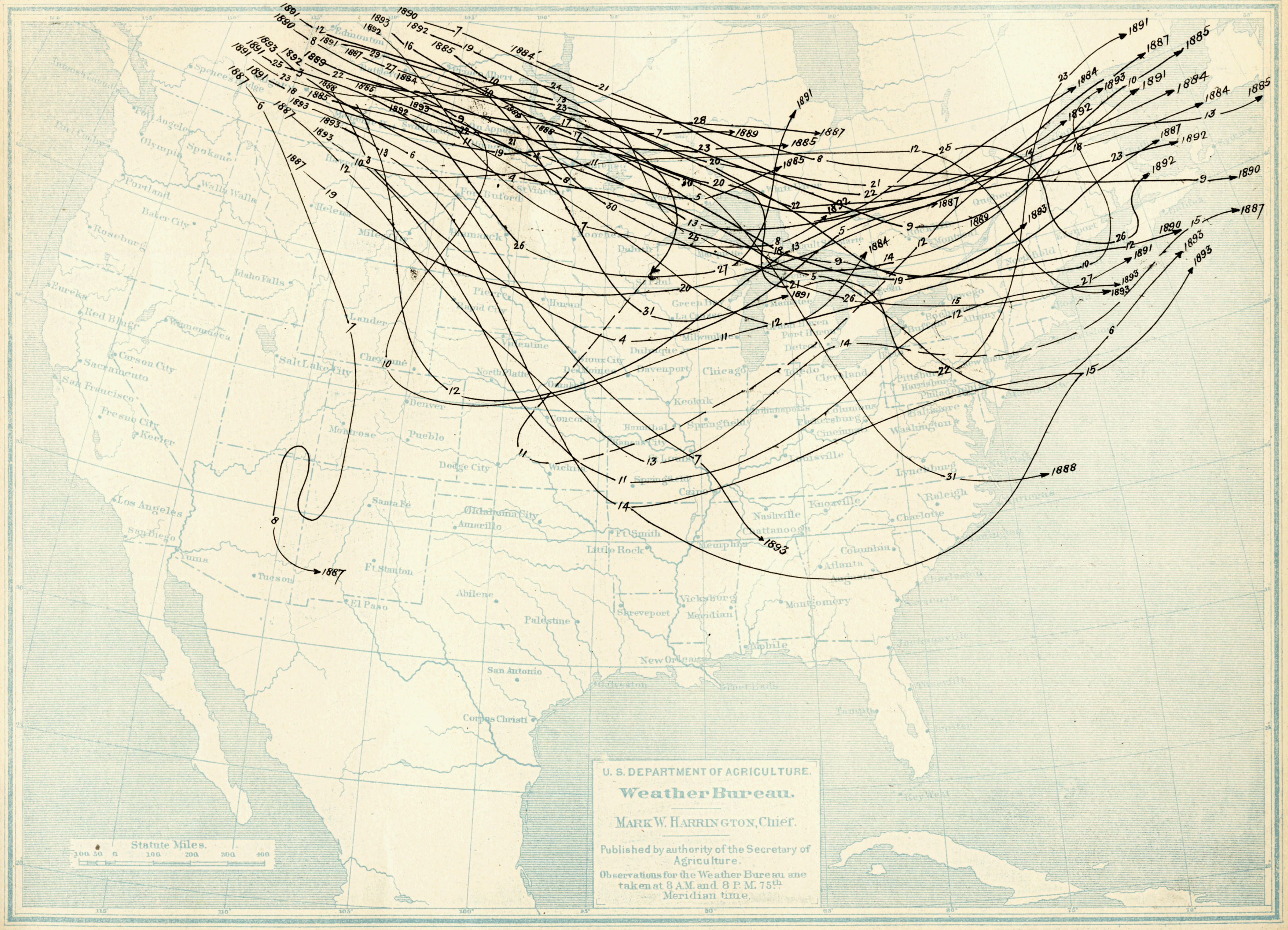


Chart 2.

Southwestern States.

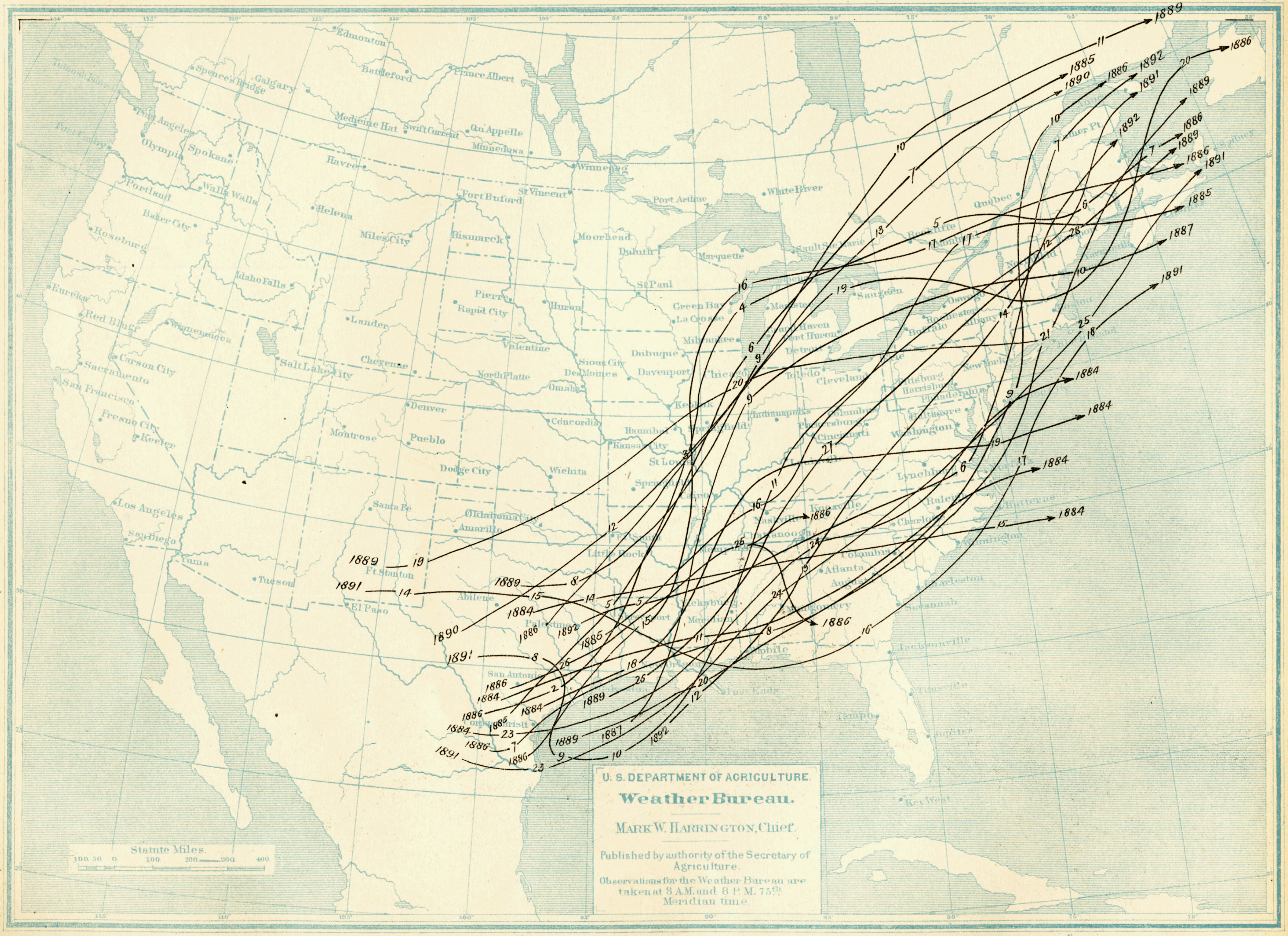


Chart 3.

North Pacific Coast.

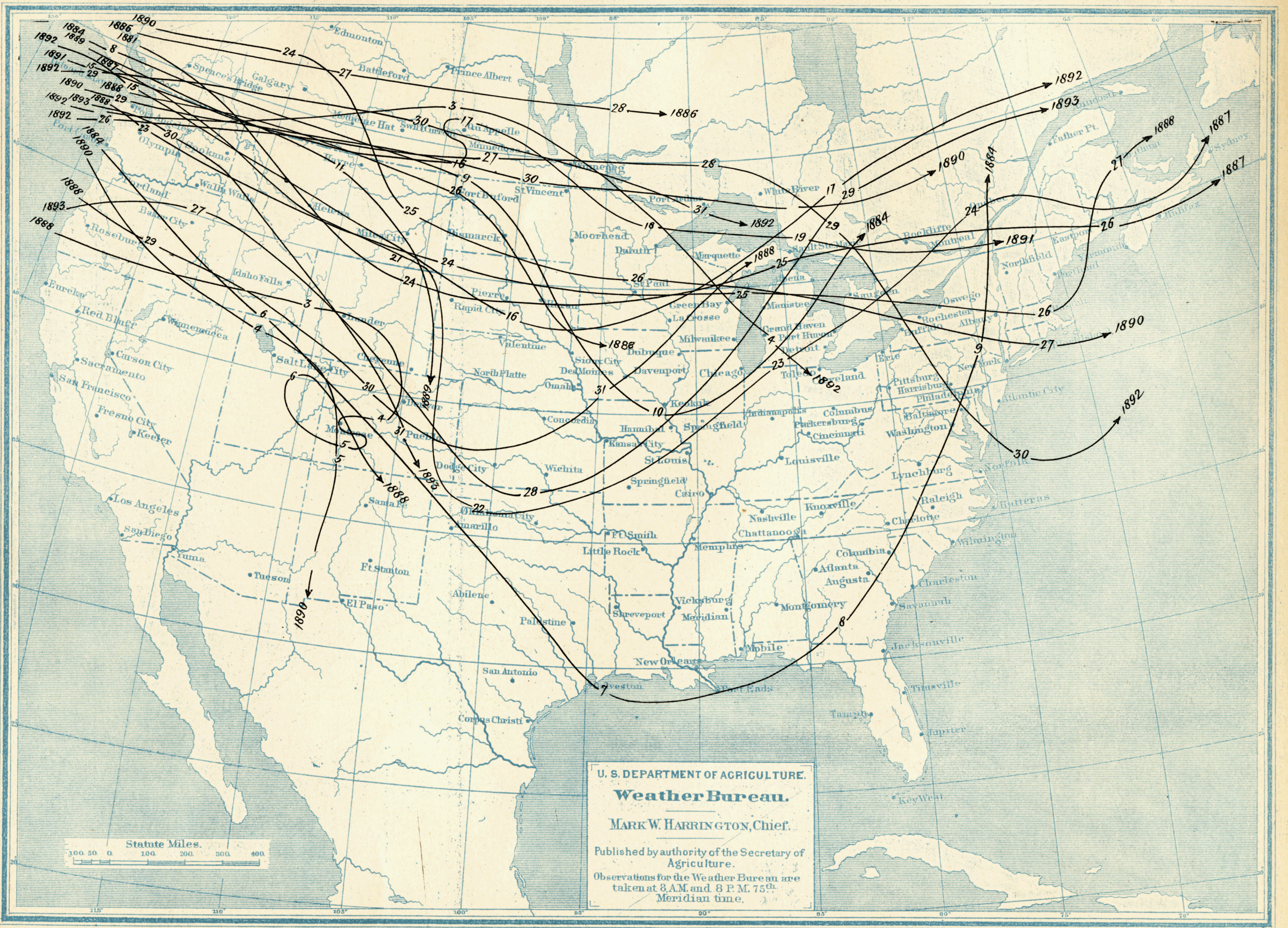


Chart 4.

Northeast Rocky Mountain Slope.

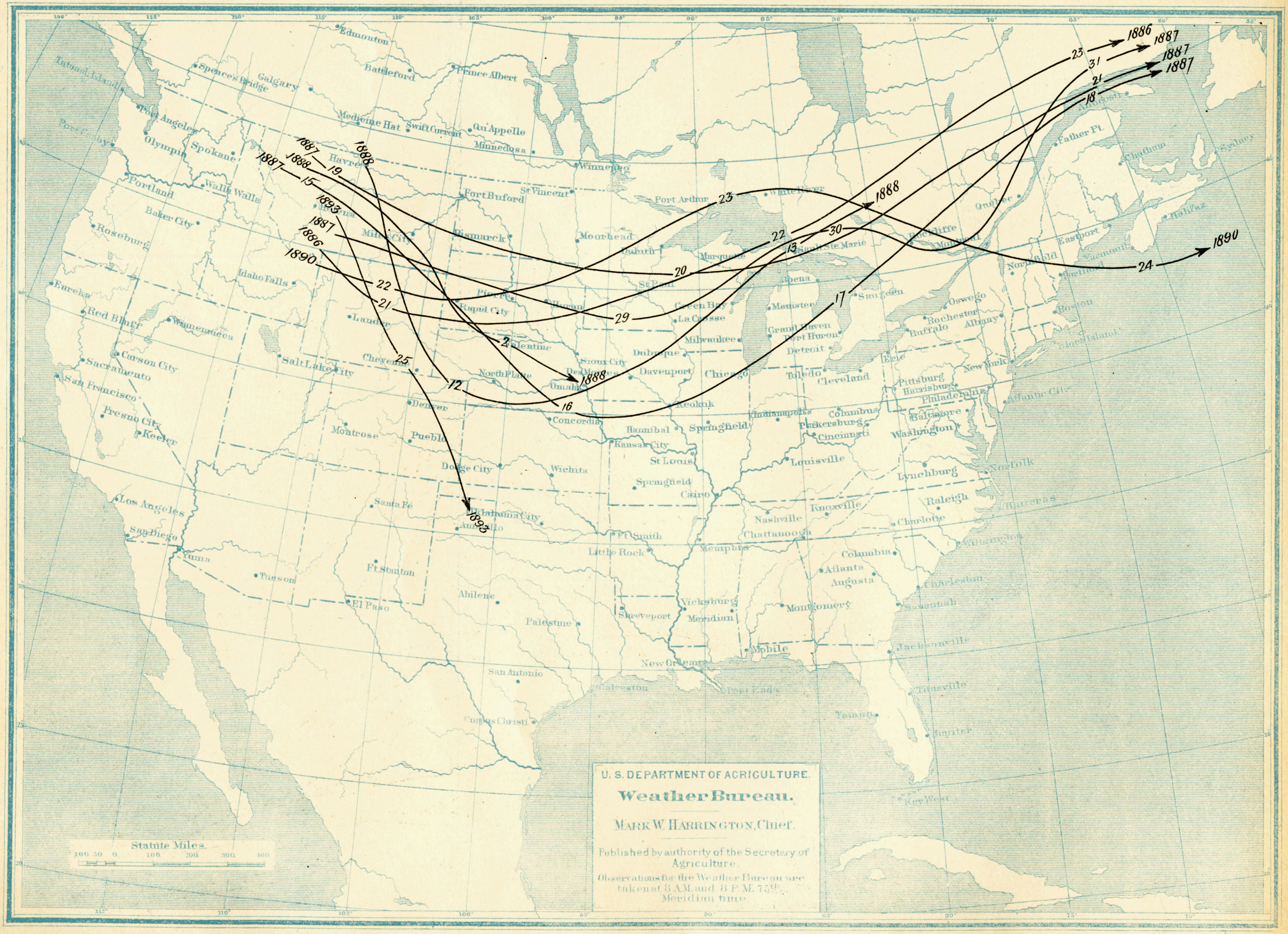


Chart 5.

Middle-Western States.

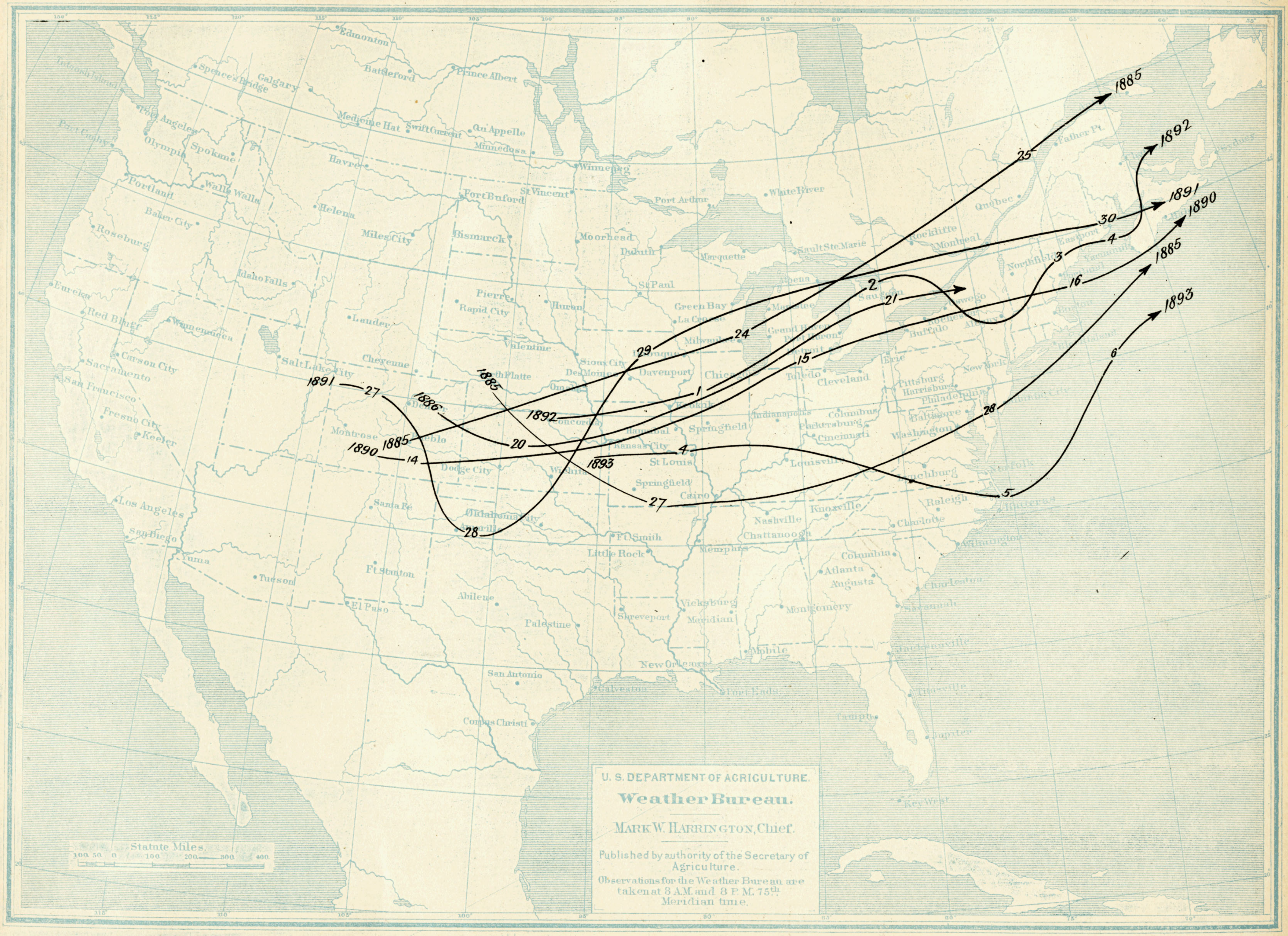


Chart 6.

Ohio Valley and Lake Region.

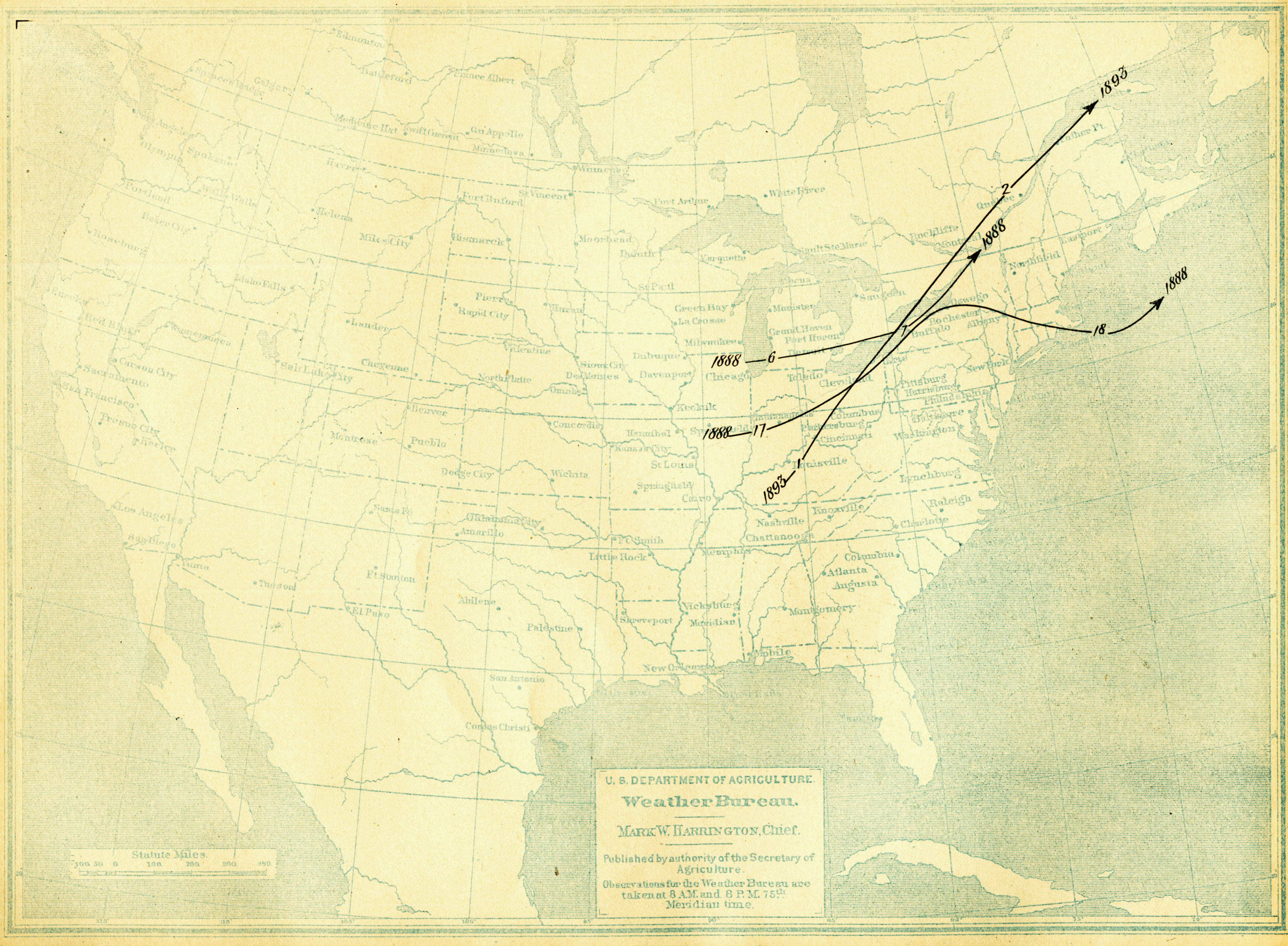


Chart 7.

Southwestern States.

Chart 8.

South Pacific Coast.

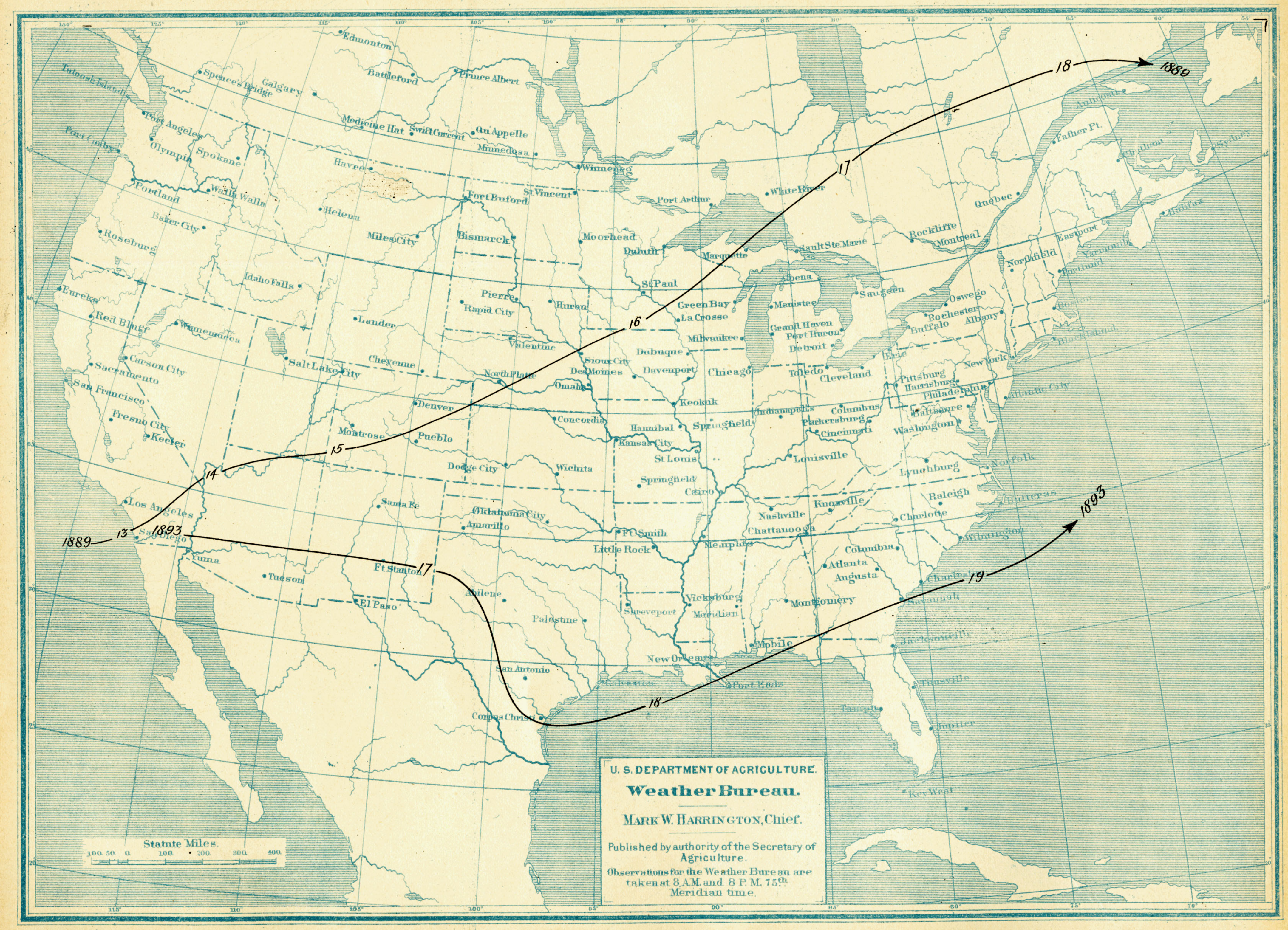


Chart 9. January 13, 1893—8 a. m.

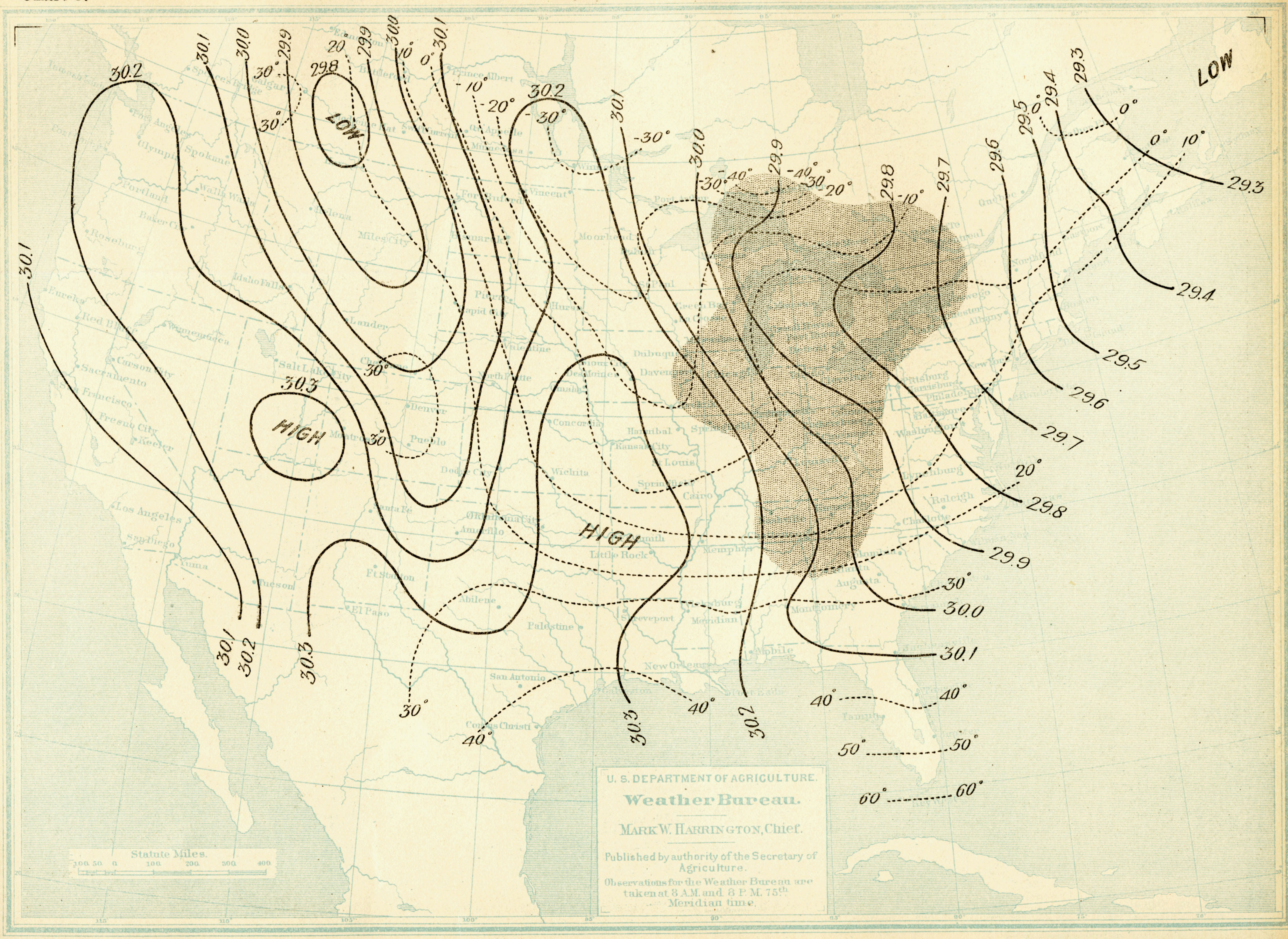


Chart 10.

January 14, 1893—8 a. m.

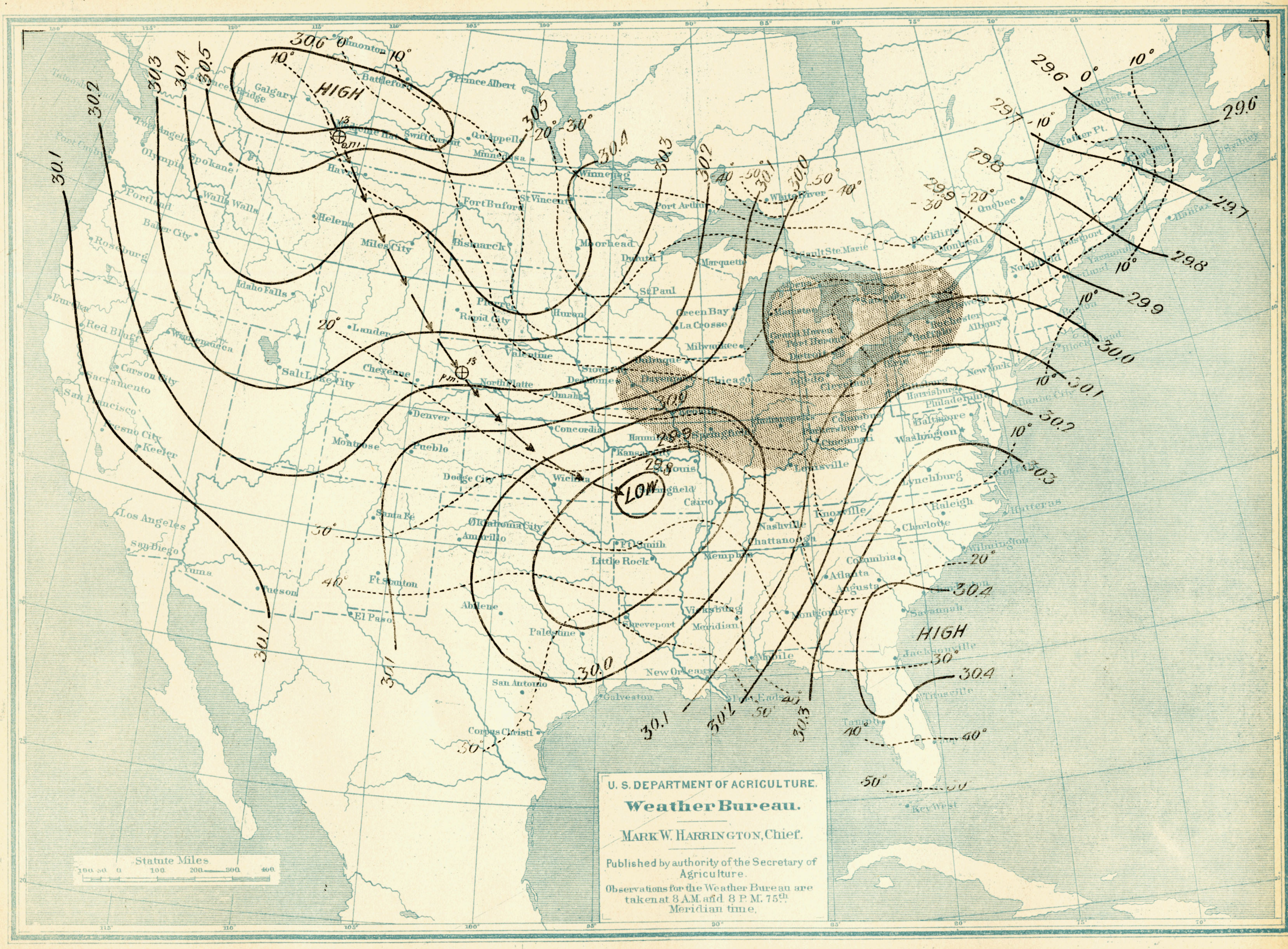
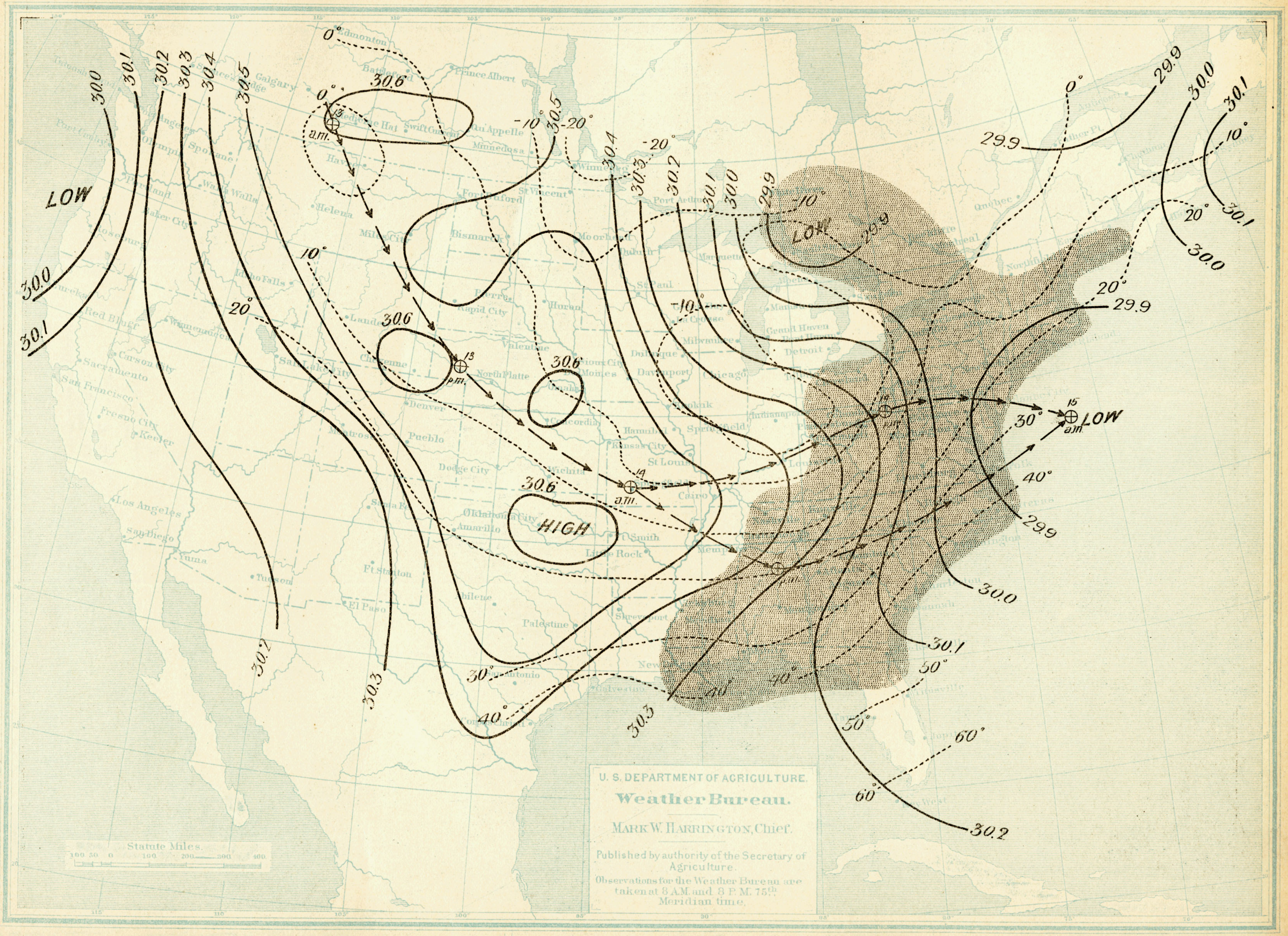


Chart 11. January 15, 1892—8 a. m.



January 20, 1892—8 a. m.

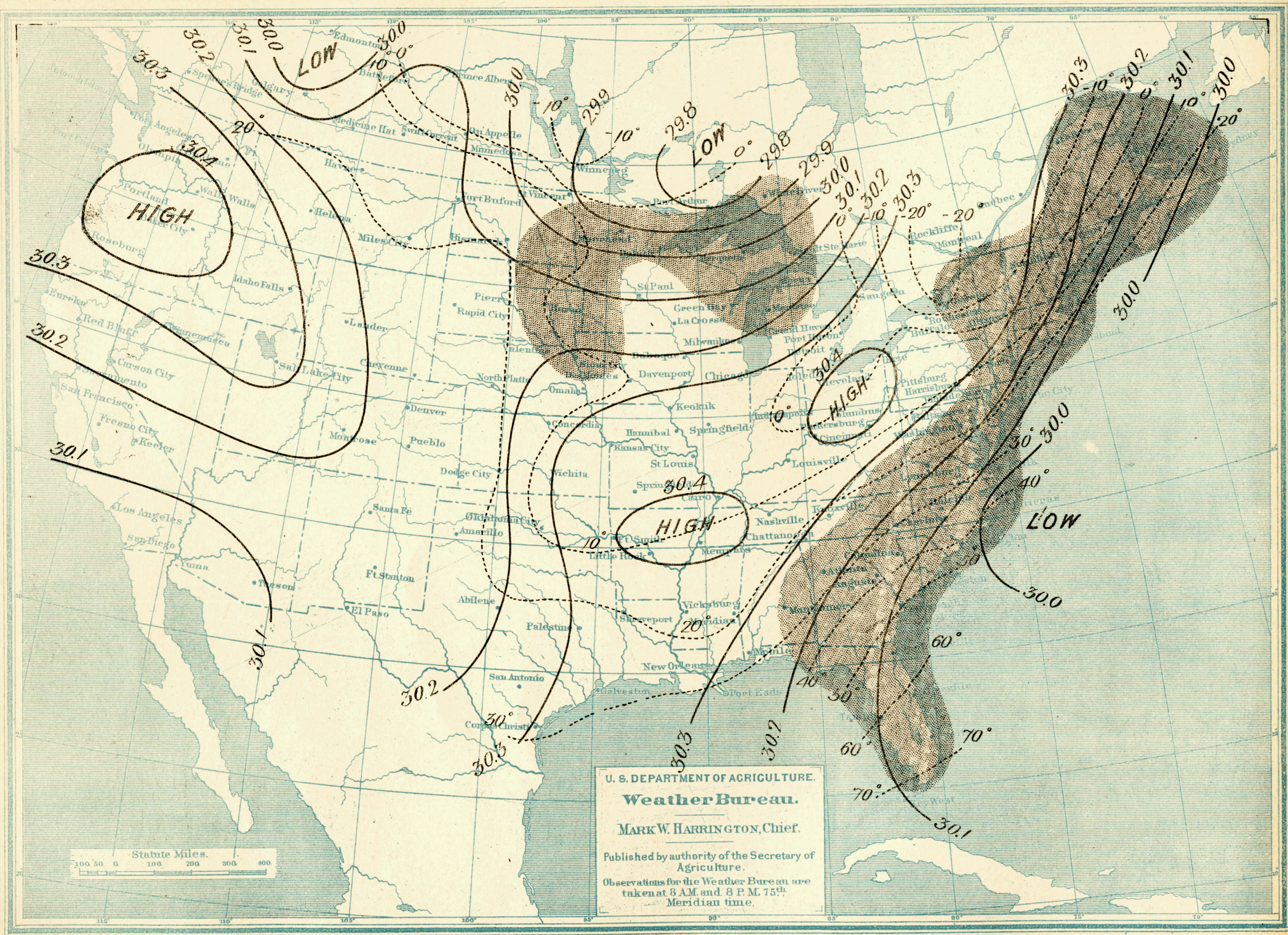


Chart 13.

January 21, 1892—8 a.m.

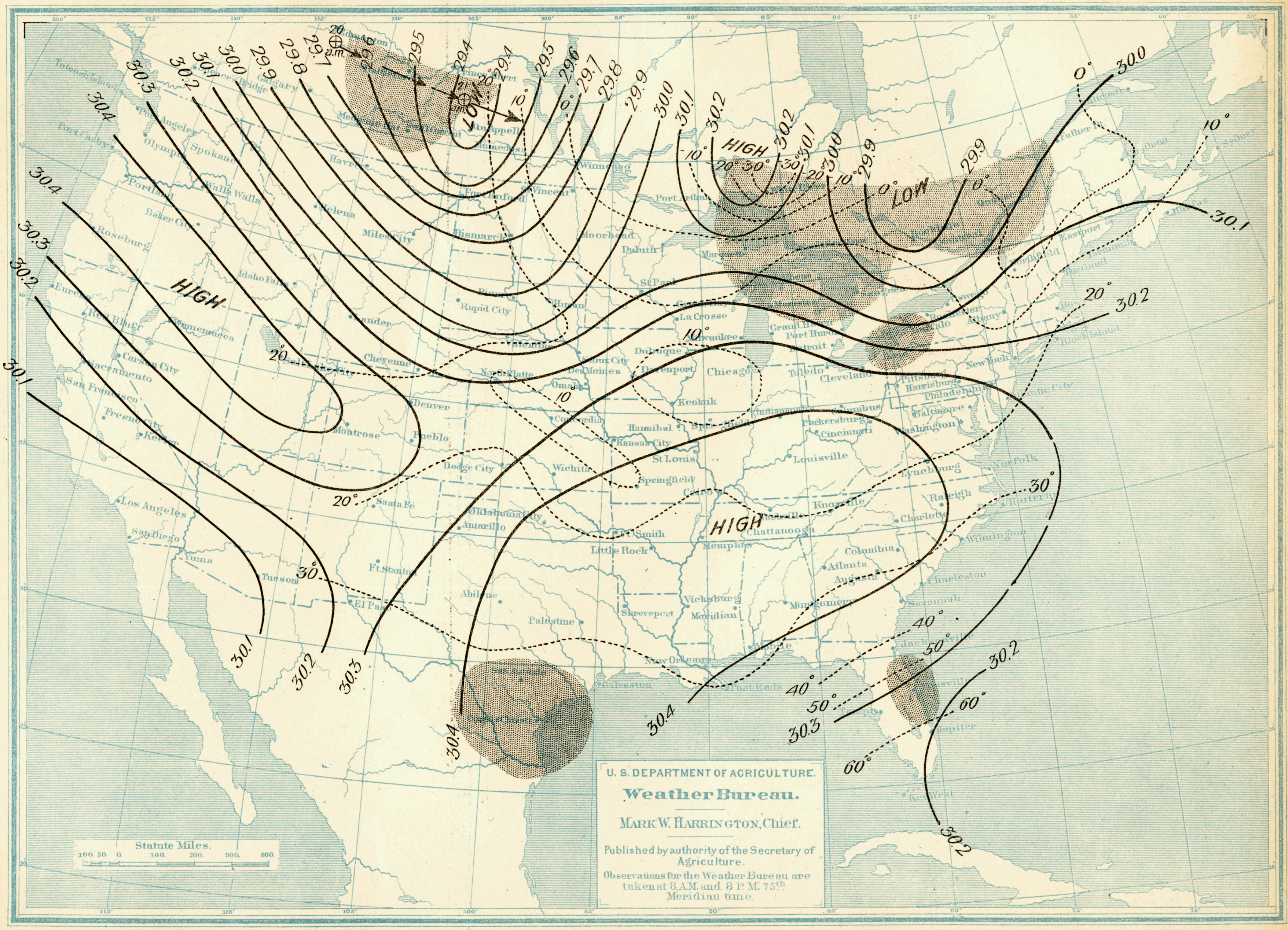


Chart 14. January 22, 1892—8 a. m.

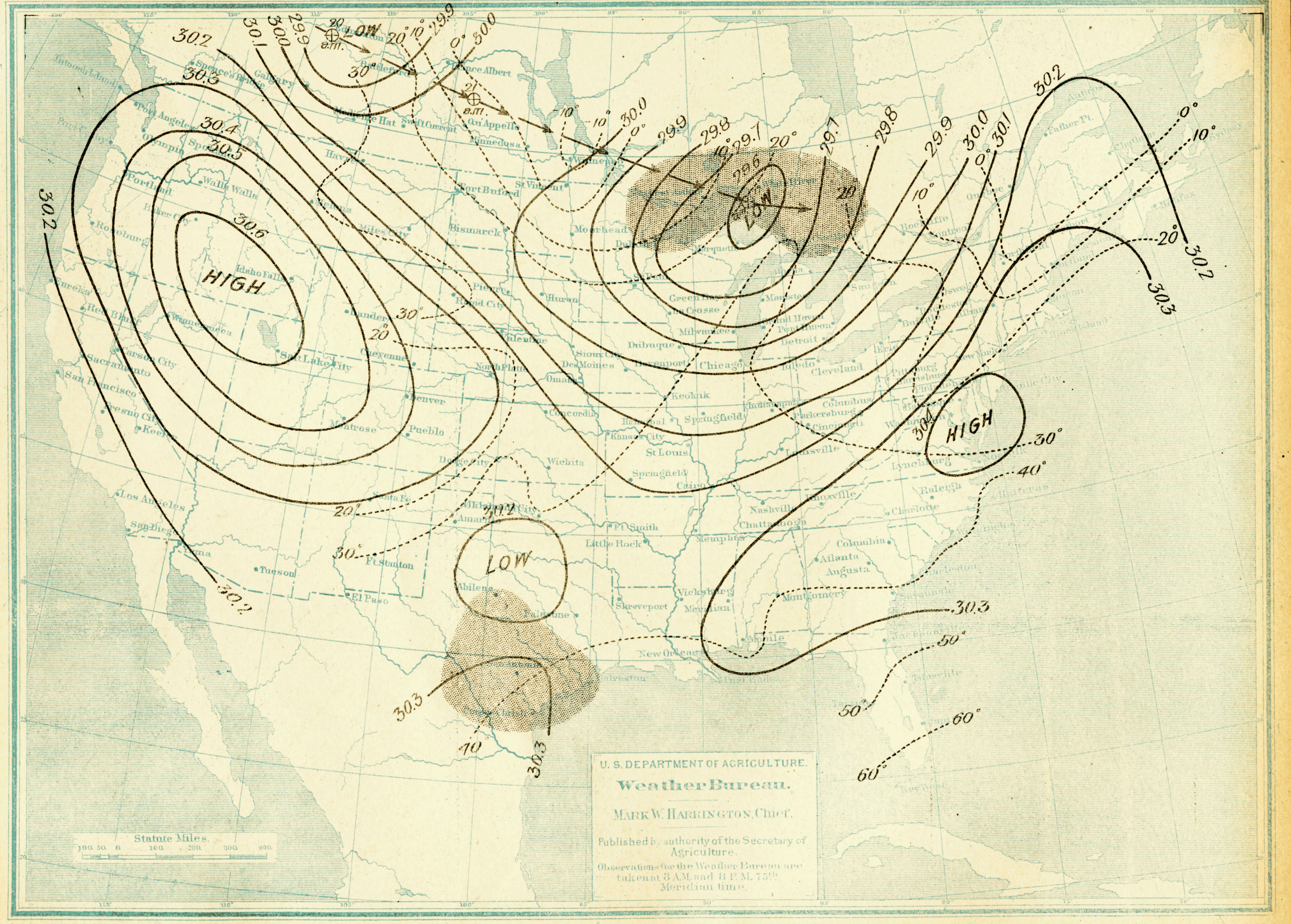


Chart 15. January 23, 1892—8 a. m.

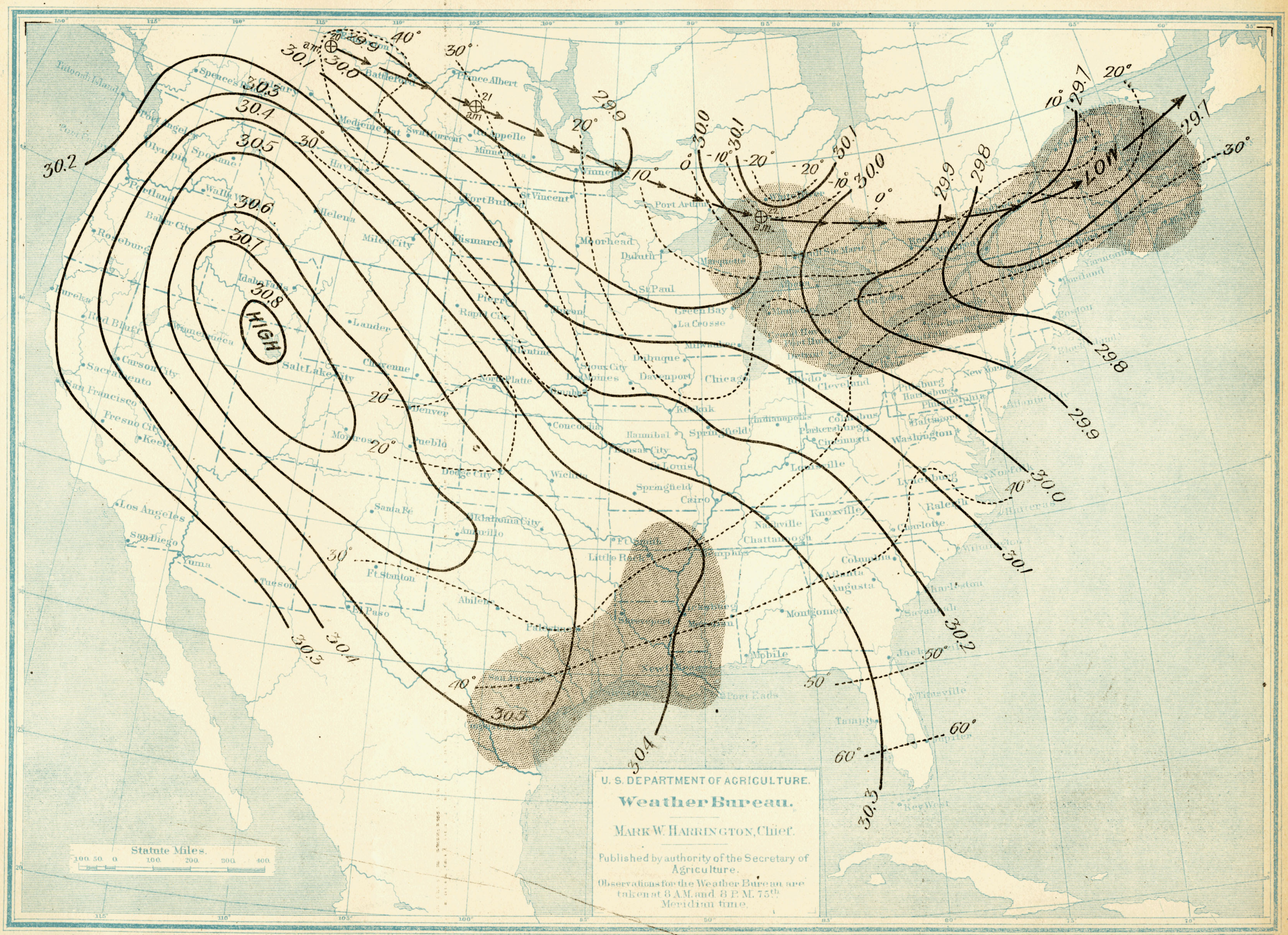


Chart 16. January 8, 1889—8 a. m.

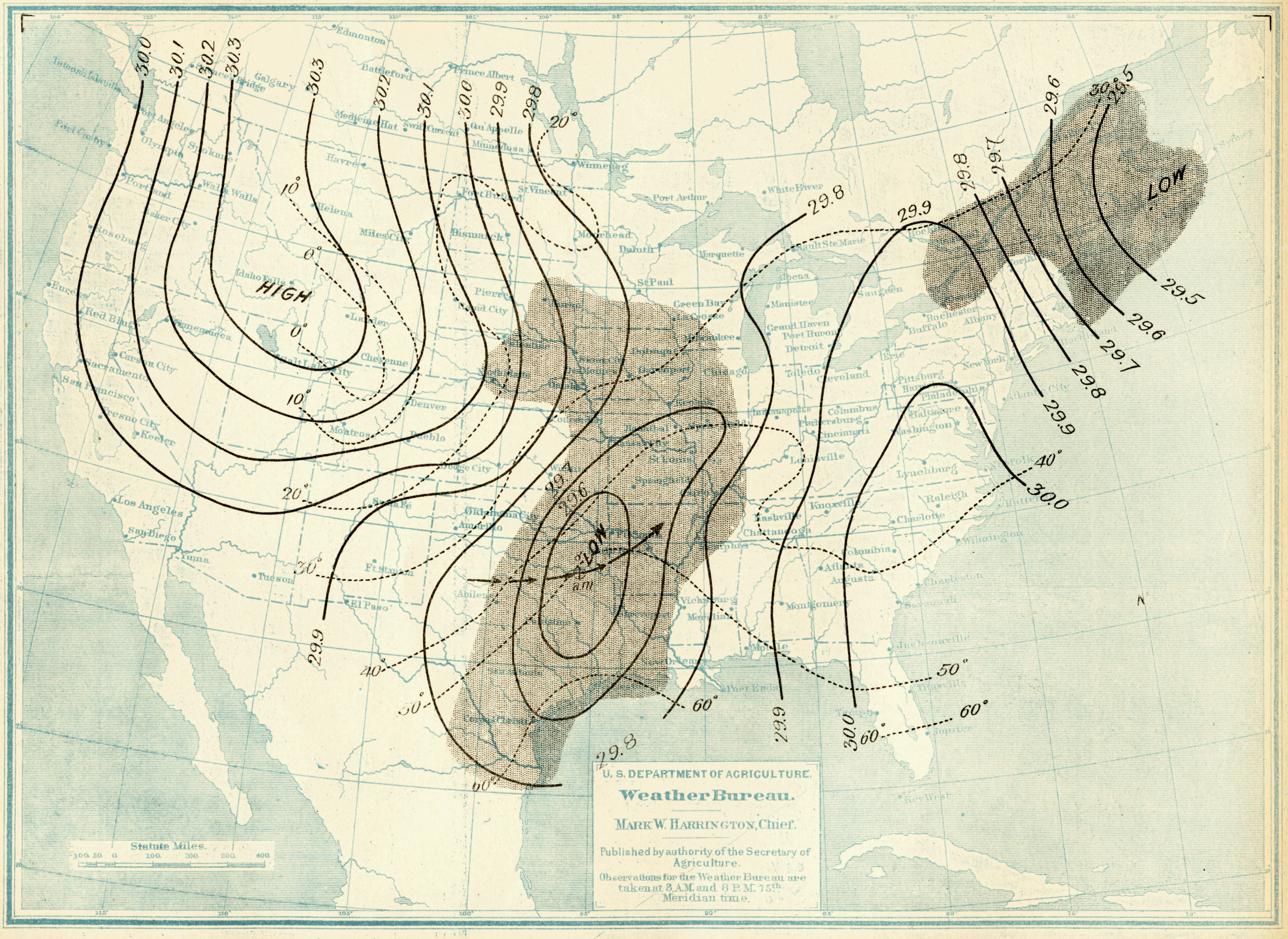


Chart 17. January 9, 1889—8 a. m.

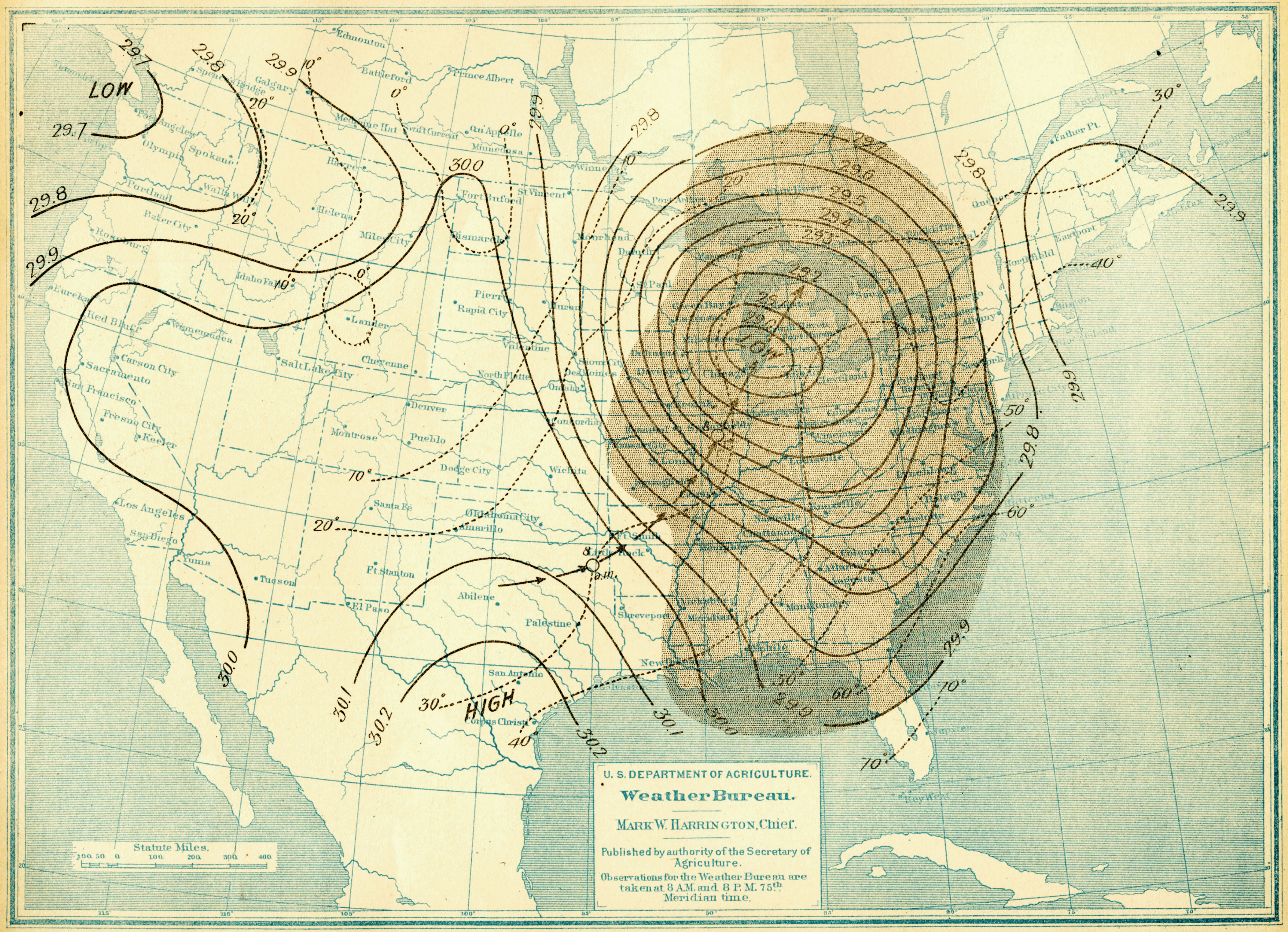


Chart 18. January 10, 1889—8 a. m.

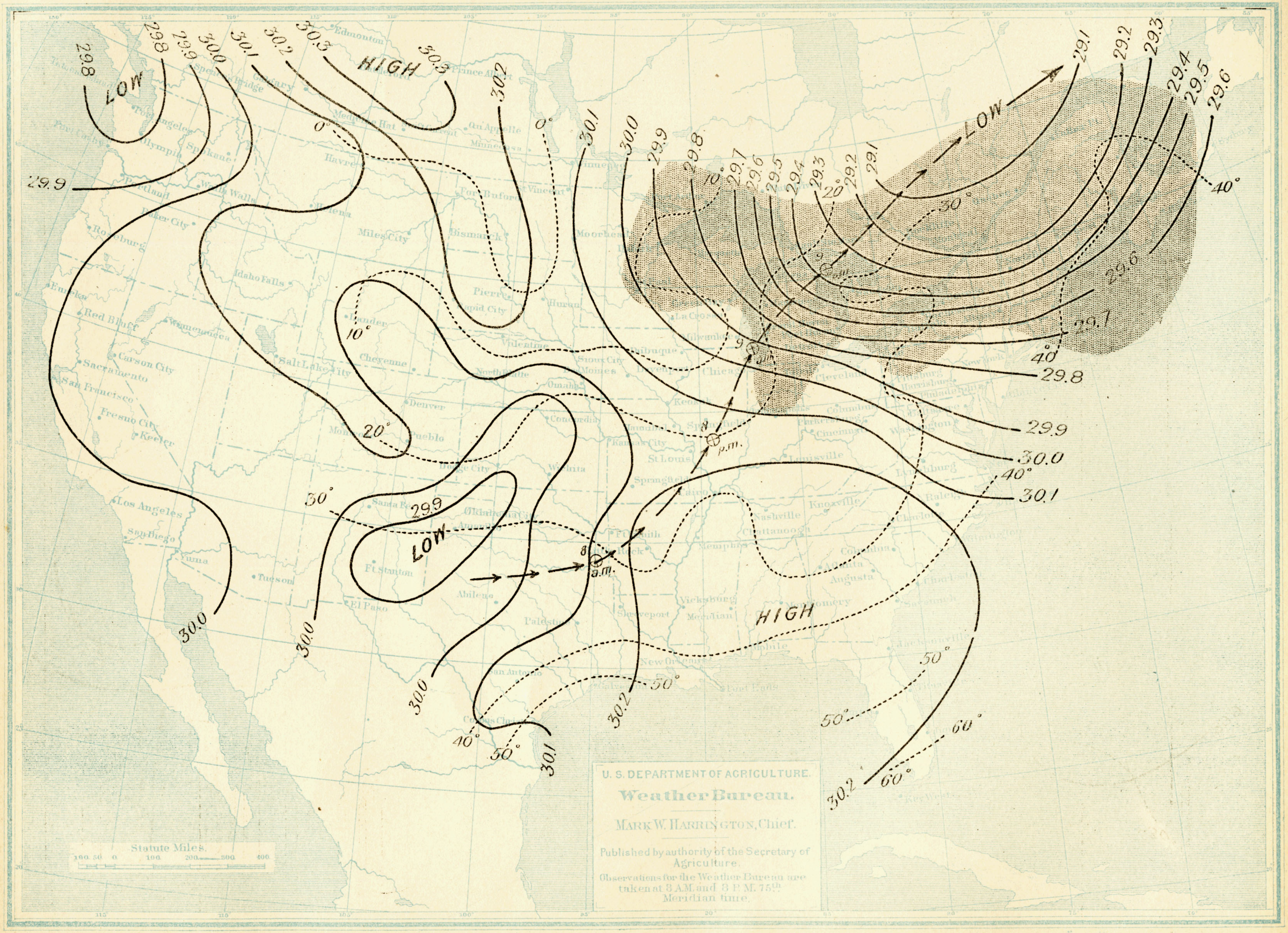


Chart 19.

January 26, 1889—8 a. m.

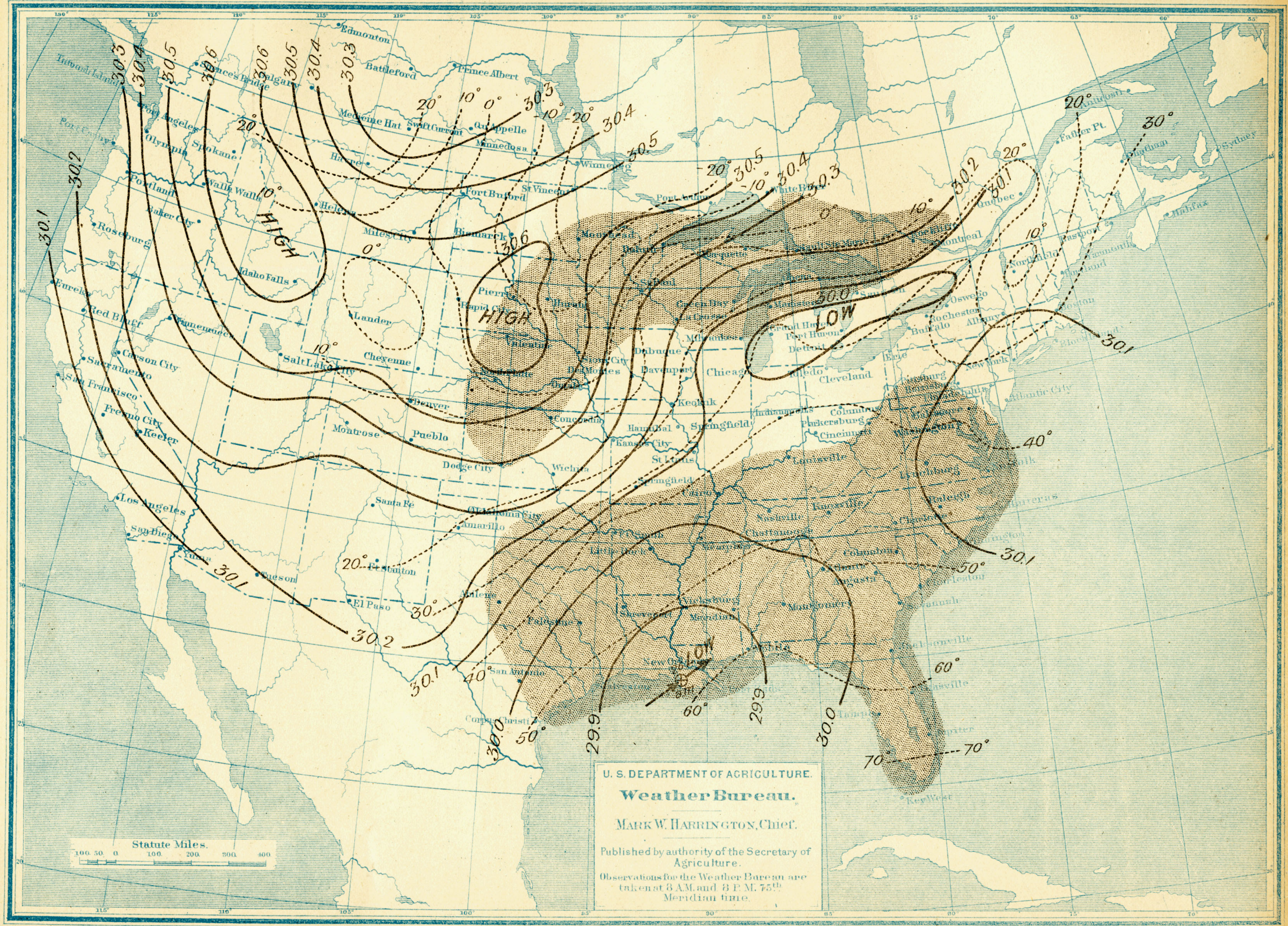


Chart 20.

January 27, 1889—8 a. m.

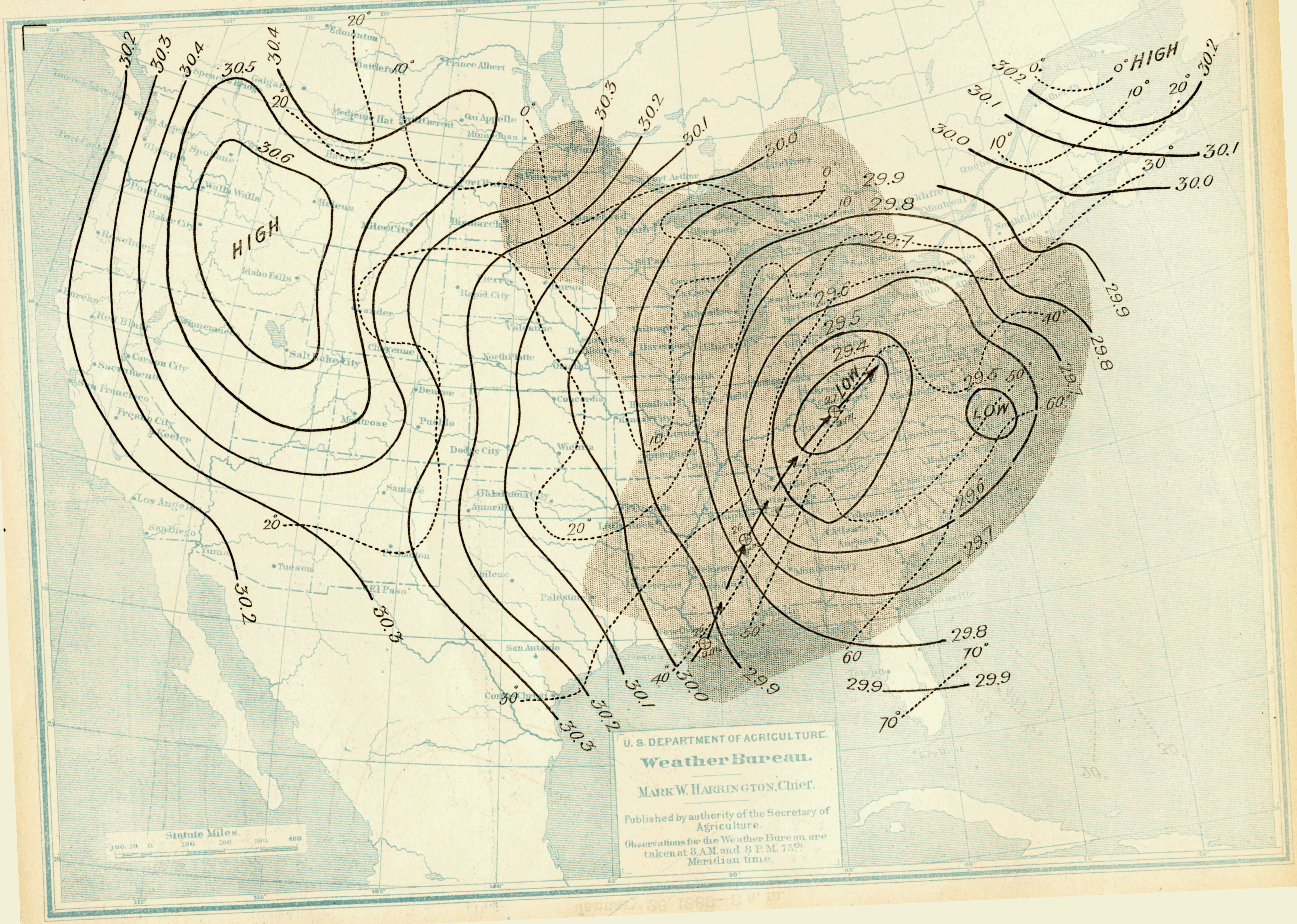
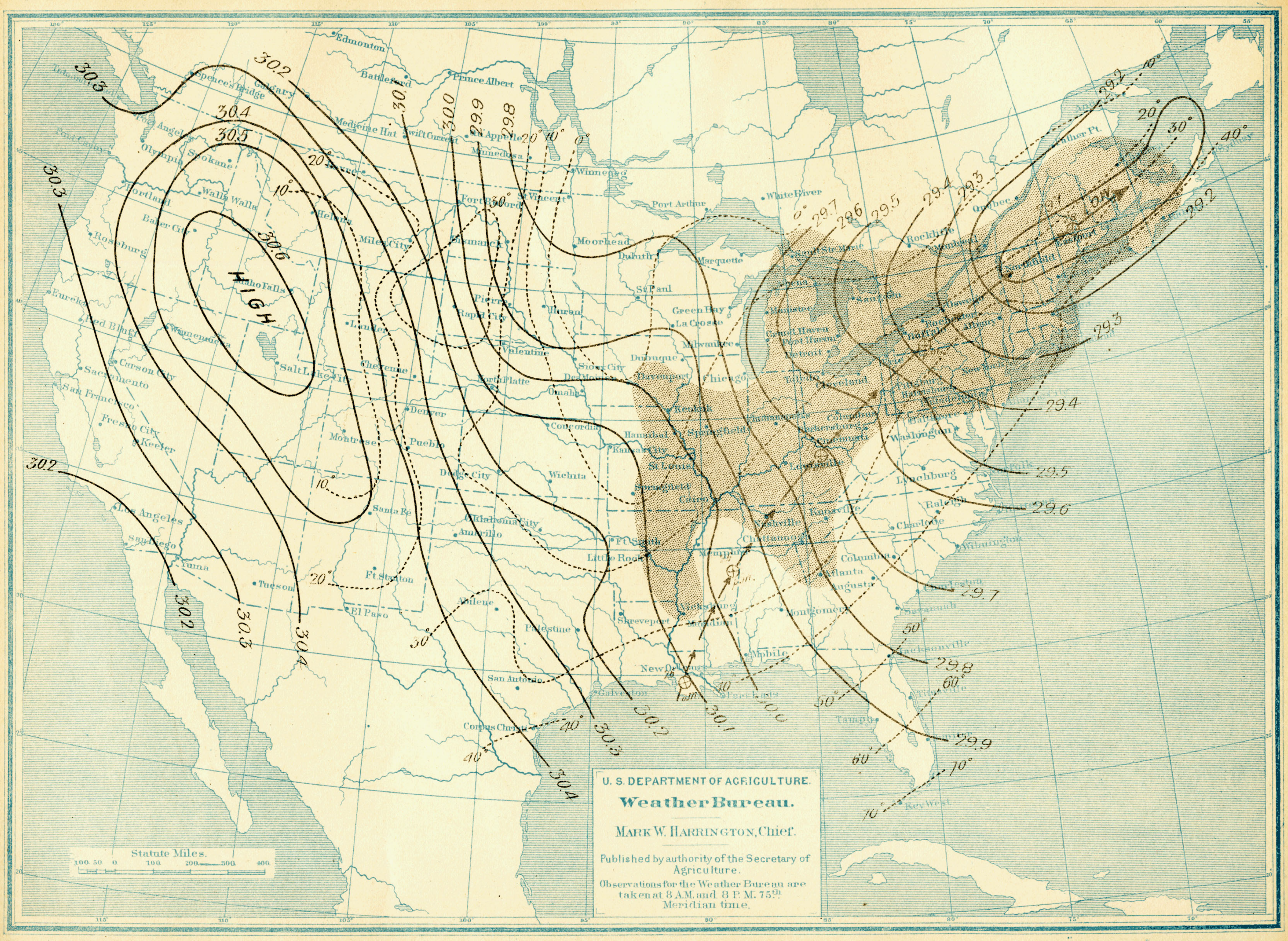


Chart 21. January 28, 1889—8 a. m.



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Weather Bureau.

MARK W. HARRINGTON, Chief.

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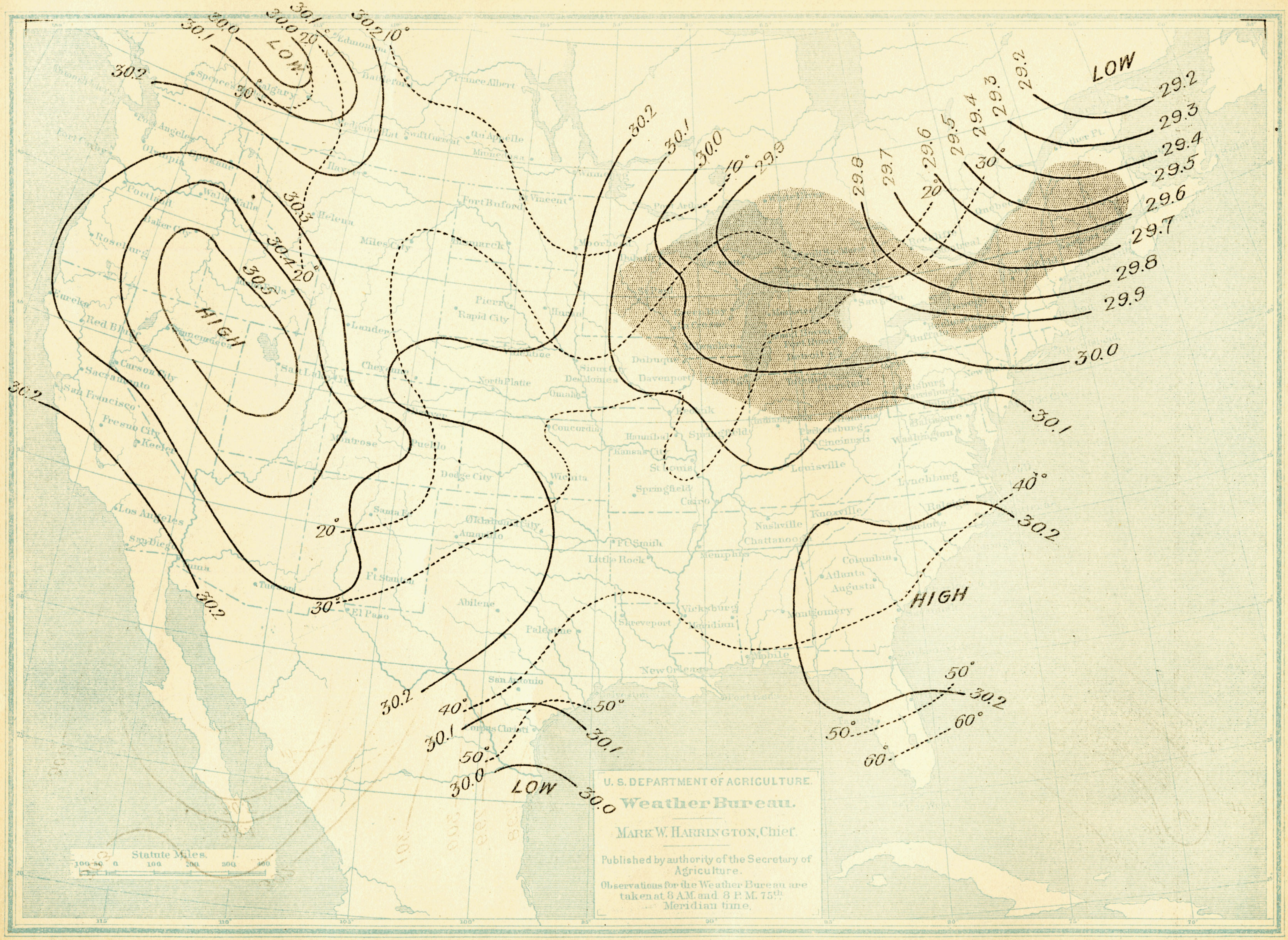
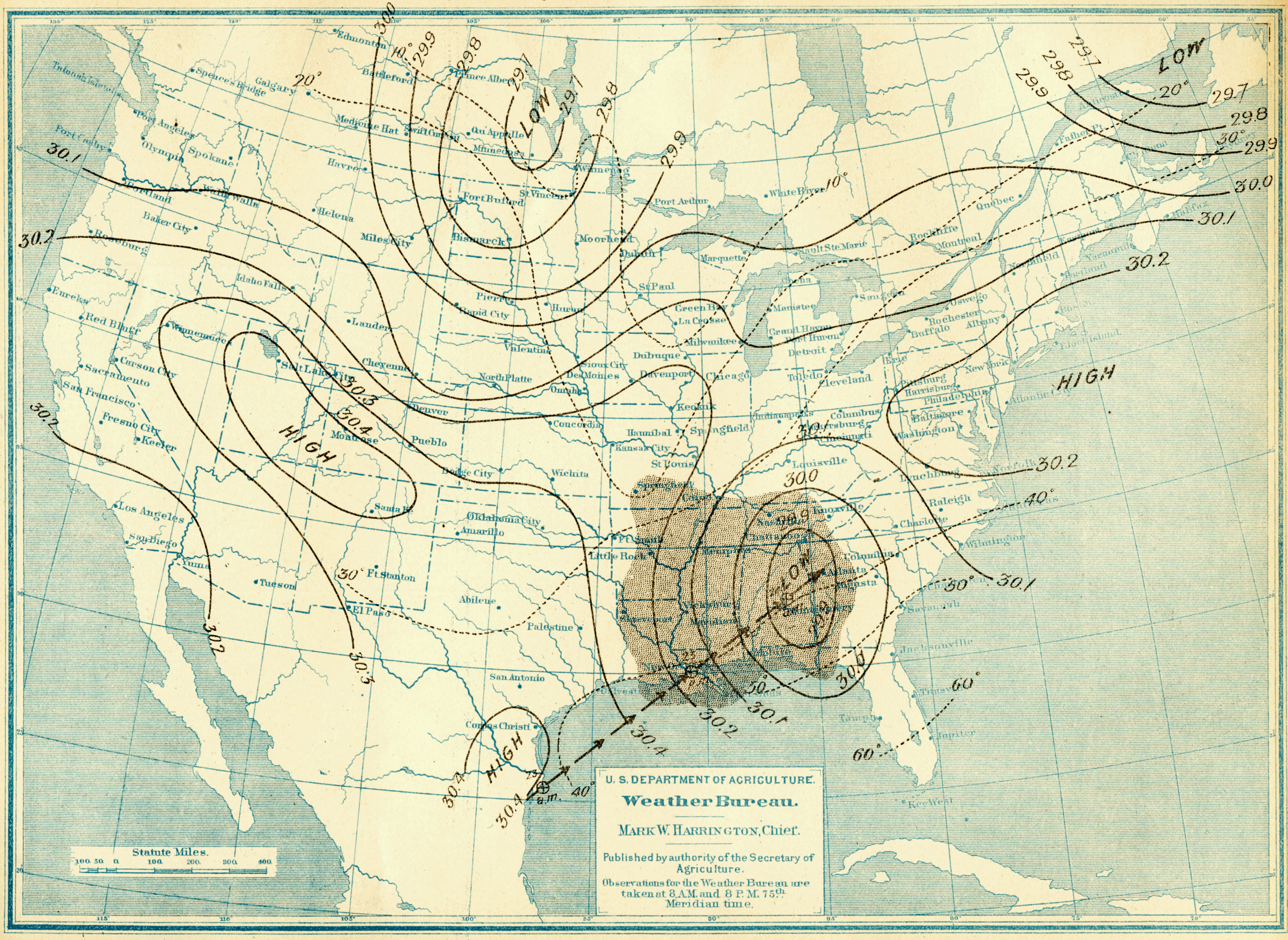
Chart 22. January 23, 1891—8 a. m.

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Statute Miles.
HIGH
LOW

Chart 24.

January 25, 1891—8 a. m.

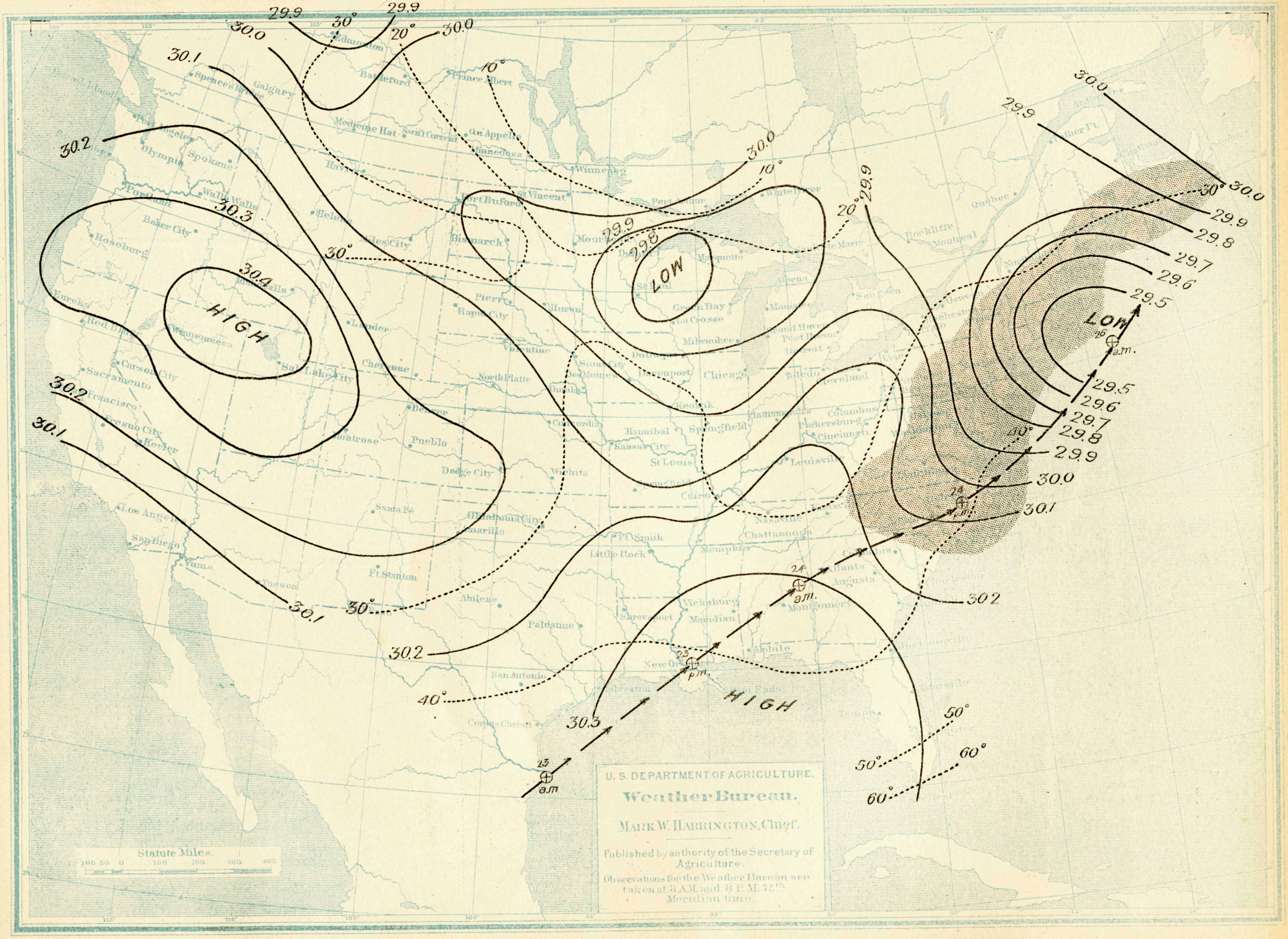

Chart 25.

Principal Types of January Storms.